Engineering News

Vol. 67, No. 24 505 Pearl Street, New York June 13, 1912

A Motor-Operated Dredge in Coral Rock

From December, 1910, to March, 1912, eight dredges were engaged in deepening the approach channel to Pearl Harbor, Island of Oahu, T. H., to provide access to the new naval station now under construction. The contractors for the work, under the U. S. Navy, were the Hawaiian Dredging Co., of Honolulu. The largest dredge used was a 20-in. suction rotary-cutter type called the "Turbine" and owned by the Standard American Dredging Co., of San Francisco. This dredge is of unusual interest from its equipment, which included an electric-motor-driven cutter head, pump, and spuds, and a steam-turbine generating set.

The dredge is 140 ft. long, 39.8 ft. wide, and has a mean draft of 12 ft. The hull is of wood; it was built on the Puget Sound and was towed to Honolulu, where the equipment was put in.

For generating steam there are two 750-hp., 200-lb. water-tube boilers with superheaters (100° F.) and oil burners. Steam at 175 lb. is supplied to the turbine of a 750-kw. 2300-volt 60-cycle three-phase 3600-r.p.m. generating set.

The turbine is a standard Allis-Chalmers power-house type, placed athwart ship. It has a specially designed oiling set which insures at all times a complete lubrication of the bearings, irrespective of smooth or rough water at the point where the dredge may be working. A surface condenser is used.

The switchboard has five panels—one for the generator and exciter, one each for the pump, cutter-head and spud-drive motors and one holding four 24-hour recording wattmeters—one for each of the three motors and one recording the total load on the turbine.

The 20-in. centrifugal pump is connected through a flexible coupling to a 750-hp. 275-r.p.m. 2200-volt three-phase induction motor. This motor is under control of the turbine attendant.

The two 75-ft. spuds are raised or sunk by a 50-hp. variable-speed induction motor. The cutter head is driven by a 250-hp. 570-r.p.m. squirrel-cage induction motor. The cutter and spud motors are under the control of a man in the pilot house. The cutter arm, which weighs 50 tons, is swung by steam winding drums. This arm has its hinged end in a notch at the bow.

Two types of cutter head were used on this contract, the one for soft materials being of the real "dental-burr" type with a number of heavy plates set on a hemispherical frame. The second head, Fig. 2, for use in coral ledge, etc., had the same number of plates, each carrying four heavy removable steel teeth. The head is on a 9-in. nickel-steel shaft which has a reduction gear at the other end. The motor and shaft gear are connected by a rope drive—the cutter head revolving 15 times per minute. In Fig. 1, the toothed cutter is shown in place and the other on deck forward.

The dredge worked to a depth of 35 ft. mean low water—average tide being 1.2 ft. The machine, however, has been successfully operated to 50 ft. depth.

The most of the spoil moved would usually be classed as suction material, consisting of "finger" and other varieties of soft coral, coral sand, shells, mud, etc. There were encountered, however, some "backbones" of ledge coral or coral limestone which would be classed as needing explosives. Several thousand yards of this hard material were removed without "shooting," and this is believed to be without precedent. About 4000 cu.yd. of such material were removed in a 24-hour day. In softer material, yardages of over 10,000 were shown per 24-hour day. The best record was 17,200 cu.yd. in 18 hr. 24 min.; this was under favorable conditions—a short discharge line and the outlet only 30 in. above water. Later from 2500 to 5000 cu.yd. per 24 hours were handled with a 4000-ft. discharge line and an outlet 17 ft. above the water; the material was exclusively coral, but not generally in ledge.

Oil fuel was used—on an average 87 bbl. (3654 gal.) per 24 hours.

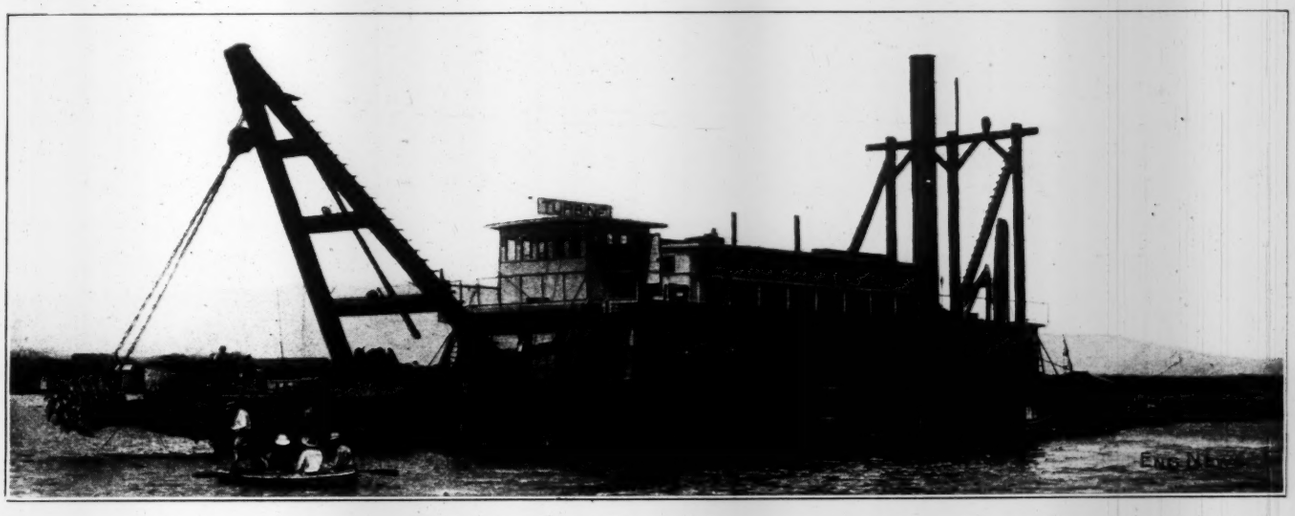

FIG. 1. THE DREDGE "TURBINE" IN PEARL HARBOR

How City Planning Bills Are to Be Paid*

By Nelson P. Lewis†

In discussing city planning there is frequently a disposition to ignore such practical questions as that which is the subject of this paper. The writer recalls one occasion at a public dinner when a gentleman of distinguished reputation in the world of art expressed his sense of humiliation that one of the speakers, who was the chief financial officer of the city, should have introduced such sordid considerations as those of cost when the discussion up to that time had been confined to things of beauty. He assured his hearers that when, a few centuries ago, the men of Sienna or Florence wanted to do something to adorn their cities, they did not stop to consider the cost but went ahead and did it and thought about the expense afterward.

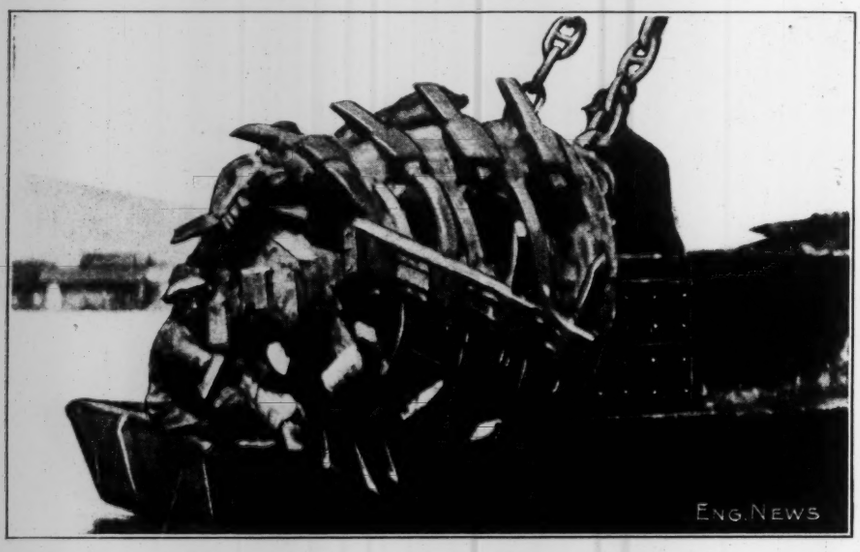

Fig. 2. Toothed Cutter Head; Dredge "Turbine"

In contrast with this a prominent officer of a real-estate holding company recently expressed his strong disapproval of any widening of streets or readjustment of street lines which were calculated to facilitate traffic whether vehicular or pedestrian. He admitted that such changes might be advantageous to the city at large and would stimulate the development of outlying sections, but as his company owned a large amount of business property in the older part of the city, he believed that the rental value of that particular property for retail shops would be greater if the movement of the people were so obstructed that they would be compelled to loiter, to look into the shop windows and go in and buy. We may have less patience with the latter than with the former point of view, yet both are inimical to real progress in city planning.

He who scorns any consideration of cost may by his enthusiam succeed in committing the city to projects which will seriously cripple its finances for years to come and render the public suspicious of any improvement, while he who openly avows his supreme selfishness may possibly arouse a feeling of indignation which will result in bringing about the very things he would like to prevent.

The question of how the bills are to be paid is not only a pertinent but a necessary one and cannot be avoided. To provide for a city of 100,000, with no apparent reason for exceptional growth, an ambitious scheme suited to a metropolis of several millions is to invite disaster; while to limit the plan of a large and rapidly growing city occupying a strategic position to one suited to its present size will seriously retard its future orderly development and may prevent it from realizing the growth and importance of which its natural advantages appear to give promise.

The feeling is common and not unnatural that if we are planning more for the future than the present, future generations which will reap the benefit should bear the greater part of the burden. It seems easy to pay with borrowed money, particularly when the money can be borrowed for fifty years or the span of two generations. The habit of paying in this way is easily acquired and is broken with difficulty. When anything is paid for with money borrowed for a period longer than the possible or even probable life of the article purchased, the city's credit is improperly used. A corporation which pays for its betterments from earnings is on sound basis. When large earnings are used to pays excessive dividends and betterments and renewals are paid from borrowed money representing additional obligations, there is danger. When interest on existing debt is paid from funds raised by incurring more debt, disaster is imminent. The only source of revenue of the American city is its power to tax. Its credit is due to this same power plus the value of its own property. The larger the city's debt which has been incurred for projects which are not self-sustaining, the greater will be the demands upon its taxing power to meet interest and sinking-fund charges due to such debt, and the less will be its ability to undertake new improvements and at the same time meet the enormous running expense of the modern city. It might not be a forced comparison to say that the ordinary service which the city renders to the public through its administrative departments, the expenses of which are met by the

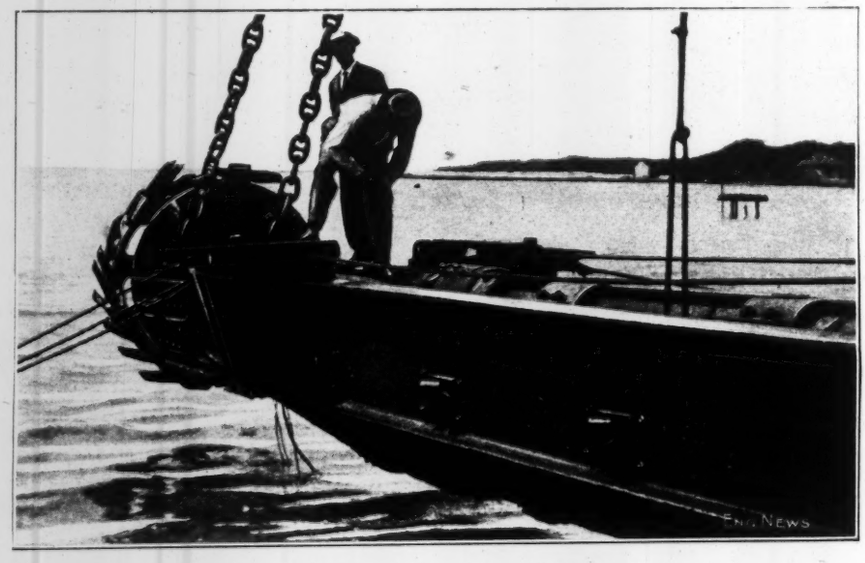

Fig. 3. Cutter Arm; Dredge "Turbine"

*A paper presented at the Fourth National Conference on City Planning, Boston, Mass., May 27-29, 1912.

†Chief Engineer of the Board of Estimate and Apportionment of New York City.

regular tax levy, are the dividends which it pays to its stockholders, while for its betterments it must issue bonds or levy special assessments. Every bond issue requires an increase in the tax levy for a term of years in order to meet interest and amortization charges, curtailing by just so much the amount which can be expended upon municipal housekeeping expenses. In order to keep the tax rate within reasonable limits, expenses which should properly be met from the tax levy are often paid with borrowed money. Is not the city which adopts this policy actually doing the same thing as the business corporation which incurs additional debt in order to pay dividends?

The class of improvements which are commonly considered city planning projects are not self-sustaining. They consist for the most part in the correction of defects due to lack of proper planning. The property affected by them has presumably been already assessed for the acquisition and improvement of streets which were at the time considered adequate for its local needs. The widening and rearrangement of streets in built-up sections will, however, improve conditions and increase values, and a part of the expense should, therefore, be placed upon the property benefited. In the more fundamental work of city planning, where unoccupied territory is being developed, the property will not have been assessed for improvements, and consequently the cost of the acquisition and construction of new streets can properly be assessed upon the adjoining property according to benefit, such benefit representing the entire cost in the case of local streets and a portion of the cost in the case of thoroughfares of metropolitan importance.

One principle should be invariably recognized, namely, where there is local benefit there should be local assessment. There can be no improvement which has been intelligently planned and executed without some local benefit, and it follows that there should always be some local assessment. No improvement, however small or however large, will be of equal benefit to the entire city and to distribute the burden of paying for it over the whole city according to taxable values is unfair in that it is not placed according to benefit. The owners of property in the immediate vicinity are frequently enriched at the expense of those whose holdings are entirely outside the district directly affected. Perhaps this statement should be so qualified as to exclude certain great improvements, such as public buildings, bridges, docks and rapid-transit lines, and yet there is doubtless a local benefit, resulting from these.

It may be urged that such things are not included in what is commonly called city planning. If so, the definition of city planning needs revision, for they are certainly most essential parts of any city plan. The City Club of New York several years ago showed that as result of the building of the first Rapid Transit Subway in New York the actual land values in those portions of upper Manhattan and The Bronx which were most directly affected were within seven years increased $80,500,000 above the normal increase for that period. The cost of that part of the subway passing through the districts where this rise in values took place was about $13,000,000, while the cost of the entire subway from the Battery north was $43,000,000. It is quite evident that if the $13,000,000 which was spent upon that part of the subway traversing the district so notably benefited had been assessed directly upon the property, its owners would still have netted a neat profit of some $67,500,000, while had the cost of the entire subway been assessed upon the same limited district, the net profit to the land owners would have been $37,500,000. Was it quite fair that property in distant parts of the city, entirely unaffected by this great project, should bear the same proportion of the burden as that which was so conspicuously advantaged? It is true that this improvement is entirely self-supporting, interest and amortization charges being provided from the rental paid by the operating company, but the local benefit was so clearly established that the rapid-transit law was so amended as to permit the assessment of any part of the cost of future subways. Many new subways are now being planned, and some are being built, but it is doubtful if any of them will be self-supporting for years, the route furnishing the most intensive traffic having been followed by the line first built. The property owners along the present operating line having secured their benefit without direct tax, those along the proposed lines are not enthusiastic about being assessed for theirs, and there seems little prospect that the right to assess will be availed of.

To take another illustration from New York: two new court houses are about to be built, one in New York County, the other in Kings County. In the former case a site has been selected to include a large area which will provide sites for still other public buildings and result in the creation of a real civic center. What will be the effect upon the neighboring property of the expenditure of the millions required for this site and building? There is abundant evidence to justify the prediction that its value will be doubled, if not trebled, by the time the first building has been completed. Is it fair or just that the owners of this contiguous property should be enriched through no action of their own and that they should bear the same proportion of the expense, according to their taxable values, as will those owning property ten miles distant?

It needs no extended argument to prove the equity and wisdom of local assessment wherever there is local benefit. That it has been done to such a limited extent in the past is no reason why it should not be more generally done in the future. That certain property owners have heretofore been treated with such prodigal liberality is no good reason why others should fatten through a continuation of an irrational and essentially unfair policy. To the degree that the assessment plan is adopted to that same degree will the city place itself upon a cash rather than upon a credit basis. It may be urged that the adoption of such a policy would discourage the agitation for and execution of many desirable city planning projects, that American cities have been slow to appreciate the advantages of intelligent city planning, and now that there has been a marked awakening it would be unwise to suggest the adoption of a policy which might dampen this new-born enthusiasm. A desire for something which involves no direct cost is not a sign of intelligent interest. We are learning that the improvement of our cities pays. That is a hopeful sign. If we have simply reached the stage where we want better conditions only if someone else is to pay the bills, the hope has not a very substantial basis. If we want them badly enough to pay for them ourselves in proportion to the benefit we feel sure will follow, we are making real progress.

Assuming that a case has been made in favor of assessing the cost of all improvements in accordance with prospective benefit, we are still confronted with a very difficult problem. The direct and indirect benefit must be estimated in advance. We cannot carry out our city planning schemes and afterward determine how the cost is to be met. Furthermore, we must determine to what extent the benefit will be strictly local, in what degree it will extend to a larger tributary area and, again, how much it will mean to the entire city or metropolitan district. In the case of the residential streets, the purpose of which is to give light, air and access to the dwellings located upon them, the benefit will be entirely local, and the entire cost can properly be imposed upon the abutting property. When a highway is given a more generous width in the expectation that it will be called upon to accommodate a certain amount of through traffic, the benefit is more extended and the assessment area in such a case may be extended to a line midway between it and the next street of more than residential width. The major part of the cost should, however, be confined to the abutting property, so that the cost to it shall be somewhat more than that of the narrower street. In the case of arterial thoroughfares, or in that of the first street to be opened through an undeveloped territory, the effect of which will be to give access to and to stimulate the development of a large area, the district of benefit will be correspondingly enlarged. Again, in the case of

thoroughfares of exceptional width, which it is proposed to treat as boulevards, the entire city or metropolitan district will be substantially benefited and should bear a portion of the expense. In fact, the state itself may derive an advantage which would justify its assumption of a portion of the cost, but the disposition to recognize such an obligation on the part of the commonwealth is exceedingly rare, even though a great city within its limits may, through its large taxable values, contribute the larger part of the state's revenues by which its rural highway system is maintained.

In the case of parks this same principle might be applied. Some small parks are of strictly local benefit, and their cost could properly be placed upon the district in which they are located. Every park, whether small or large, is of some local benefit, even if such benefit were deemed to consist solely in unobstructed light and air to the property on the surrounding streest.

In the case of street widenings or the cutting through of new streets, the local advantage is less marked, thought it will always follow. The mere fact that a widening or extension is required to accommodate traffic is conclusive evidence that the street has assumed more than local importance. The width of the roadway as widened is not an index of its local or general importance. There may be cases where the opening of a new street of a width commonly given to local streets and extending for a very short distance would on account of its strategic position be of very great general and of little local benefit.

It is quite apparent that the relative local, district or general benefit of any street or other improvement can be determined neither by its dimensions nor its cost. An improvement involving an expenditure of $1,000,000 in one part of the city may be more distinctly local in its beneficial effect than one costing $50,000 in another section. No fixed rule can be established to govern the distribution of expense. It must be determined in each case after a painstaking investigation. Such investigation should not be intrusted to a different individual board or commission in each case. There should be a permanent body which should act in all cases. This body should not be large, and it should be so constituted that its entire personnel could not be changed at once, thus insuring continuity and consistency of policy. They should be broad men whose training should have fitted them for their difficult and delicate duties. The misleading evidence commonly called expert testimony as to existing and prospective values will be of little value to them. They should be capable by experience and intelligence of forming their own conclusions.

While no definite rule can be adopted to govern the distribution of assessments representing the district and general benefit, it should be possible to prescribe a method of determining the amount and extent of local benefit, particularly in the case of new streets, boulevards and parks. Let us assume that 60 ft. is the normal and maximum width required for a local street; then the entire cost of acquiring and improving all streets 60 ft. or less in width may properly be placed upon the property within a half block on either side of the street. In the case of wider streets that proportion of the cost represented by the ratio which 60 ft. plus 25% of the excess over 60 ft. bears to the width of the street would probably be an equitable proportion to assess upon the local district. Inasmuch as property fronting a wide street is more valuable, it would be manifestly unfair to adopt a rule which would result in making the cost of a 70- or 80-ft. street less to the abutting owner than would have been the cost of a street 60 ft. wide. On the other hand, after a street reaches certain proportions, additional width will not involve additional benefit. It may be assumed that a share of the expense which would be equivalent to paying for a street 80 ft. wide should represent the limit of local assessment. This limit would be reached under the rule proposed when the street becomes 140 ft. wide. The percentage of cost which would be locally assessed would, therefore, be as follows for various street widths: 60 ft., 100%; 70 ft., 89.3%; 80 ft., 81.25%; 90 ft., 75%; 100 ft., 70%; 120 ft., 62.5%; 140 ft., 57.1%; 150 ft., 53.3%; 200 ft., 40%.

In the case of parks the problem is more difficult, the amount of local assessment and the extent of the area of local benefit being determined by the size and shape of the park and facility of access to it from other parts of the city. In any case, no rule should be adopted until it has been carefully tested and it has been demonstrated that the assessments levied in accordance with it will constantly decrease with the distance from the improvement. This decrease should not be directly in proportion to the distance, but in a geometrical ratio. A curve to determine the distribution of the assessment after the limits of the district have been decided has been proposed by Arthur S. Tuttle, Assistant Chief Engineer of Board of Estimate and Apportionment of New York City, in accordance with which about 32.5% of the assessment would be placed upon the first 10% of the distance to the outer limit of the area of benefit, 55% on the first 25%, and 80% on the district extending halfway to the boundary of the assessment area.

In the case of street widenings involving destruction of buildings, it is suggested that the same general principles be adopted as in the case of new streets, but that they be applied to the land values only. If the street were less than 60 ft. wide, the proportion of the expense for additional land in order to make it 60 ft. would be assessed upon the half block on each side, while for all excess over 60 ft. the same rule already proposed could be adopted. For instance, if a street 50 ft. wide were to be widened to 80 ft., involving the acquisition of 30 ft. of additional property, the first 10 ft. required to make it 60 ft. and 25% of the 20 ft. over 60 ft., a total of 15 ft., or one-half of the cost of the land to be taken, might be assessed locally, the expense involved in damage to buildings being included in the district assessment, or the general assessment if the improvement were of sufficient importance to involve general benefit. If the same street were to be widened to 100 ft., the local assessment under the same rule would be for 20 of the 50 ft. to be acquired, or 40% of the total land damage, the damage of buildings, as before, being included in the district or general assessment.

Special cases will undoubtedly arise which would require special treatment, but it is probable that in the great majority of improvements the method proposed would result in an equitable distribution of the burden. Those who are to pay the bills have a right to know in advance how the costs are to be apportioned, and the formulation of a policy which can be consistently followed is not only desirable but necessary.

The problem of determining whether or not there is general benefit and the proportion of the cost representing such benefit will be difficult. A typical case is that of a new boulevard recently laid out in the City of New York and now being acquired. It has been given a width of 200 ft., and extends from one of the great bridges over the East River directly across the Borough of Queens to Jamaica, and it is expected that it will ultimately be carried to the ocean front. It will afford ready access not only to the highway system of the Borough of Queens, but to all of Long Island. It includes within its lines an existing highway about 80 ft. in width. Owing to its strategic position, this boulevard will be of more than local benefit. It was thought proper in this case to assess upon an area extending 800 ft. on each side that proportion of the cost of acquiring title represented by increasing the existing highway from 80 ft. to 100 ft. Of the remaining 100 ft. it was decided to impose three-eighths upon the Borough of Queens and five-eighths upon the city at large. This division would have placed upon the local area, the borough and city, 16.7, 31.2 and 52.1%, respectively, but these were rounded off to 20, 30 and 50%. In the improvement of this highway it is proposed to construct one central driveway 44 ft. wide, with parking spaces 30 ft. wide on each side, and outside of these

side roadways 28 ft. and sidewalks 20 ft. in width, the side roadways and walks to be treated strictly as local improvements and the cost of their construction to be assessed directly upon the abutting property, the central driveway and parking spaces to be treated as a part of the park system and to be built at the expense of the entire city. It is believed that such a distribution of expense is just, but there has been a disposition to consider it a precedent for similar treatment in the case of other streets where the general public benefit would be far less, while in some instances there would be none.

Demands for the apportionment of the expense of local streets as though they were thoroughfares of metropolitan importance must be consistently denied, however powerful may be the influences exerted to induce special treatment in certain cases. A policy which is manifestly just will ultimately win popular favor. Hastily to adopt a plan for the distribution of costs which afterward proves unworkable, and which must therefore be modified, will involve some injustice as between those who may have been assessed by one plan and those whose burdens may be determined by a revised plan. The policy should, therefore, be carefully studied and thoroughly tested before its adoption, after which it should be consistently adhered to. It follows that such a policy should be confined to principles, rather than be expressed in percentages, for special cases will inevitably occur where a principle can be applied, while a rigid rule involving fixed percentages would entail serious hardship.

There is one other method by which the expense of city-planning projects could be met, at least in part, namely, through recoupment by the exercise of the right of excess condemnation where this right exists.

Where the financial condition of the city will permit, the burdens of the property owner can be considerably lightened by the recognition of deferred benefit and a correspondingly deferred assessment. In this case the city would carry the account until the benefit resulting from the improvement should have been fully realized, or, in other words, should have been reflected in actual increase in values. Similar relief could be given by permitting the payment of assessments in installments carrying a moderate rate of interest. Either plan would require larger capital to finance such improvements, and would to that extent impair the city's borrowing capacity for other purposes. These, however, are matters of detail and have to do with the manner of collection of the assessments, rather than the distribution of the expense. The general principles which should, in the writer's opinion, govern the distribution of the cost of city improvements, may be briefly summarized as follows:

(1) Where there is local benefit, there should always be local assessment.

(2) The entire city or the metropolitan district should bear no part of the expense unless the improvement is in some degree of metropolitan importance and benefit.

(3) Assessments should not be confined to the cost of acquiring and improving streets, but should extend to any improvement which will increase the value of the neighboring property, and should be apportioned as nearly as possible according to the probable benefit.

(4) A workable policy once adopted should be consistently adhered to.

(5) The determination of a policy and its application to each case should be entrusted to a board composed of men especially qualified, whose terms of office should so overlap as to insure continuity of policy and purpose.

The Third International Road Congress, London, 1913

The Third International Road Congress will be held in London, from Monday, June 23, to Saturday, June 28, 1913. This will be the first Congress to be held in an English speaking country. The first Congress was held in Paris in 1908 and the second in Brussels in 1910. Hereafter these Congresses will be held triennially.

The Congress will be divided into two sections. The first section, on construction and maintenance, will have two subdivisions: (a) construction and maintenance of roads outside towns; (b) construction and maintenance of roads in towns. The second section, on traffic and administration, will also have two subdivisions: (c) traffic and vehicles; (d) administration, finance and statistics. The subdivisions of each section will hold joint sessions to consider questions of common interest. Papers and reports by leading authorities throughout the world will be presented on the maintenance of roads, their foundations and proper drainage, the prevention of dust and mud, the laying of light railways and tramways on roads, the choice of surfacing materials, the influence of weight and speed of vehicles on roads and bridges, the conditions that should be filled by horse- or mechanically-propelled vehicles in order that they may not damage or suffer damage from the roads, and on other topics.

The 1913 Congress is held in England on the invitation of the British Government and is under the patronage of King George V. Excursions have been planned to various places of interest, including Windsor Castle, where the King has intimated his intention of entertaining the delegates at afternoon tea. Receptions will be given to the members of the Congress by the Lord Mayor and Corporation of the City of London at the Guildhall, by the Committee of the Royal Automobile Club in their new premises in Pall Mall and by the Institution of Civil Engineers in their building now under construction at Westminster. An exhibition of road machinery, material and appliances used in road construction is being arranged to be held in connection with the Congress.

Membership in the Congress is open to all. The individual membership subscription is $5 (1£) and that for associate members, namely the wives and children of members, is $2 (8s. 4d.). Either of these subscriptions entitles the member to take part in all excursions and entertainments, and the full membership subscription gives the right to take part in the proceedings of the Congress and receive the daily agenda as well as a copy of the full reports of the discussions and decisions and a complete set of the papers presented.

The London Chairman of the Organizing Committee is Sir George S. Gibb, Chairman of the Imperial Road Board. The Treasurer is Sir Charles D. Rose, Bart, M. P., and the Honorary Secretary is W. Rees Jeffreys, Secretary of the Road Board. Mr. Jeffreys arrived in New York, June 4, on the steamship "Minneapolis," for a tour of this country and Canada to arouse interest in the Congress. He will not return to Europe until about the middle of July. His address for mail during the interval will be in care of The American Road Builders' Association, 150 Nassau St., New York.

Investigation of Accidents on the Southern Pacific Ry. is provided for in an order recently made public at the general offices of that company. Some years ago the Southern Pacific adopted a policy of full publicity regarding accidents. The new feature of the present order is the provision for regular boards of inquiry. The ranking official on the division where an accident occurs is to take charge of the investigation and convene the board, which shall comprise two disinterested persons not connected with the railway and the division officers representing the operating, mechanical and engineering departments. The board must visit the scene of the accident and take the testimony of employees and eye witnesses, persisting in the investigation until the causes are determined. Should this board fail to reach a decision, a second board comprising higher officials shall be convened, and if the findings of this second board are not conclusive, the general manager will convene a third board. The findings of the board are to be turned over to the general manager and by him to the press. A somewhat similar board-of-inquiry system in use on the Union Pacific Ry. was described briefly in Engineering News, Feb. 15, 1912, page 306.

The Tunkhannock Creek Bridge on the Lackawanna Railroad

The accompanying two halftones are taken from photographs of a model of what will be the largest concrete bridge which has ever been built for railway purposes. The Tunkhannock Creek viaduct is now in course of construction in connection with the new Summit cut-off of the Delaware, Lackawanna & Western R.R.

The viaduct is to be built across the main branch of Tunkhannock Creek near Nicholson, Penn., some 15 miles west of Scranton, Penn., and within a few hundred feet of the point where the present line of the Lackawanna crosses that stream. It will be constructed for two tracks and a total length of 2230 ft. It consists of ten 180-ft. full centered reinforced-concrete arches and two 100-ft. full centered abutment arches which latter are concealed by the earth fill in the view shown in Fig. 1. The 180-ft. arches will be built in two ribs, each 14 ft. wide and 8 ft. deep at the crown, separated 6 ft. from each other as shown in the view in Fig. 1. The upper offset on each of the piers shown at about 20 ft. below the springing line is for the support of the steel centers to be used in casting the arch.

The maximum height of the structure from top of rail to the lowest point in the bed of the creek is 240 ft. and as all piers will be carried to rock foundation at some places a depth of 95 ft., the maximum height of the piers from base to rail grade will be about 300 ft. These piers will be about 40x46 ft. in plan at the ground line and 28x34 ft. exclusive of the pilaster at the springing line. In all the structure will contain approximately 164,000 cu.yd. of concrete and 1140 tons of reinforcing steel. The contract for its construction has been let to Flickwir & Bush, Inc., of New York City, and work is now in progress in installing the construction plant.

Along the same cutoff another large viaduct will be constructed across Martins Creek south of Kingsleys, Penn. This will consist of seven 150-ft. three-centered arches and two 50-ft. full centered arches. This structure will be built for three tracks and the 150-ft. arches will be built in two ribs each 17 ft. 6 in. in width. The main dimensions of the Martins Creek viaduct are: Total length, 18 ft.; maximum height from ground, 150 ft.; maximum height top of rail to rock foundation, 170 ft.

The Summit cutoff on which these two large structures are to be built is a change of alignment for the purpose of reducing grades and eliminating curvature. Its total length is approximately 38½ miles, starting at a point seven miles west of Scranton, Penn. The roadbed will be constructed for three tracks throughout and for four tracks for a portion of the way. The maximum east-bound grade is now 70 ft. to the mile, and this will be reduced to 36 ft. to the mile, while the maximum west-bound grade, now 35 ft. to the mile, with most of it running 21 to 22 ft. per mile, will be reduced to 12½ ft. per mile, compensating for curvature. A total distance of 3.6 miles and 2300° of curvature will be eliminated.

For all of the concrete work in the structures in this cut-off, the "autoclave" boiling-pressure test, described on the next page, is required.

The entire cutoff, together with the many structures thereon, is under the charge of G. J. Ray, Chief Engineer, the Delaware, Lackawanna & Western R.R. Co., Hoboken, N. J.,

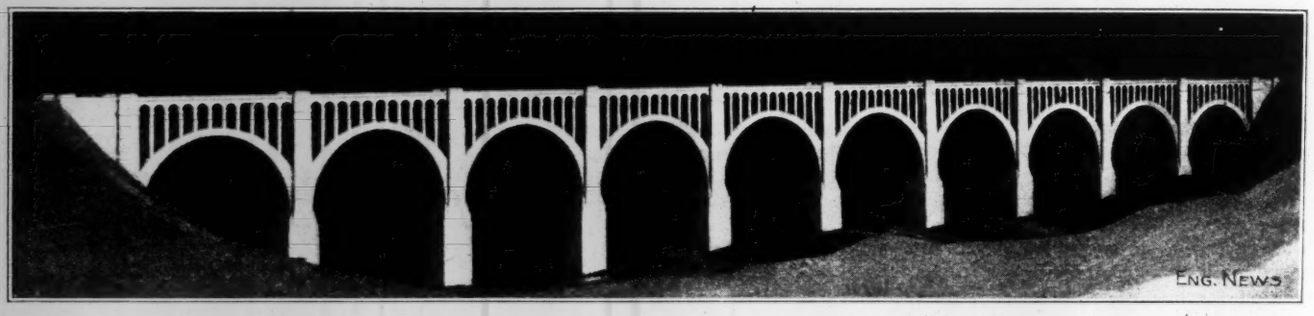

FIG. 1. THE TUNKHANNOCK CREEK VIADUCT, D., L. & W. R.R.
[Photograph of a model.]
(Ten 180-ft. reinforced-concrete arches, rail grade 240 ft. above lowest part of valley.)

Motor Trucks for Municipal Haulage have been investigated by C. H. Cooper, Engineer and Surveyor of the Borough of Wimbledon, England. A table summarizing the results of this investigation, published in "The Contract Journal," May 8, 1912, gives first costs, running expenses per ton-mile and annual costs for horse and motor haulage in 38 different districts in England. The materials hauled were house refuse, road materials, water for street sprinkling, etc. The costs per ton-mile ranged from 18c. to 27c. by horse haulage and from 9c. to 20c. for motor haulage.

Most of these data were for short hauls of less than five miles. The average hauling distance in Wimbledon for road material is one mile. Motor haulage is only economical for long distances, Mr. Cooper states, and is not economical for the removal of house refuse.

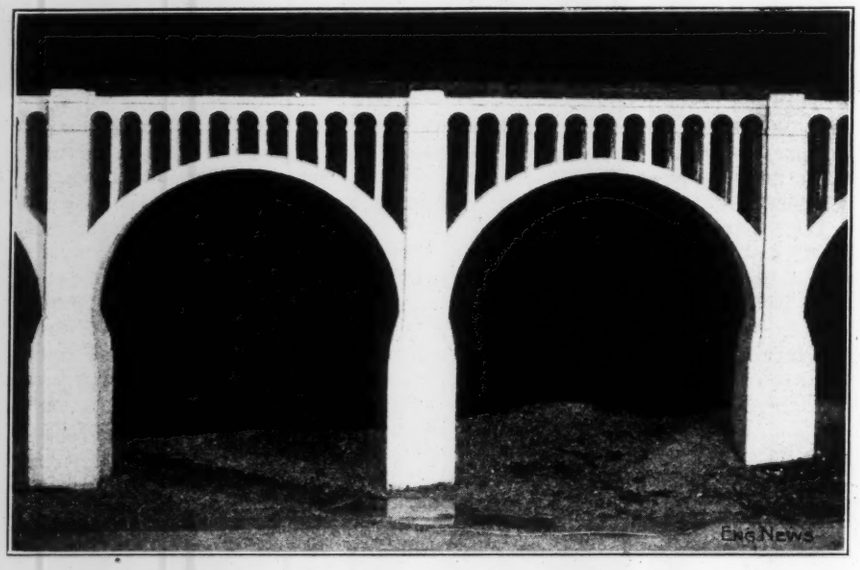

FIG. 2. DETAILS OF THE 180-FT. ARCHES
[Photograph from a model.]

Autoclave Boiling Test for Cement

By H. J. Force*

The Lackawanna R.R. is now demanding that portland cement used on its structures shall pass 78% through a 200-mesh sieve instead of 75% as demanded by the standard specifications of the American Society for Testing Materials, and furthermore that the cement shall remain sound after being subjected to boiling under 20-atmosphere pressure, the so called autoclave test. This is a very radical diversion from current practice and as such should be interesting to all cement users. The following account describes the test and the behavior of cements under it.

*Chemist and Engineer of Tests, Delaware, Lackawanna & Western R.R., Scranton, Penn.

Few fields of study are more fruitful of results and lead to more genuine progress than the study of the cause of failures. Such studies may be unpleasant and disagreeable at times, they may be even disheartening, but the men who make substantial advances must heed the lessons which failures teach. It is also true that valuable information can be obtained from a study of materials which have given good service, and ofttimes in attacking a difficult problem a comparison of the properties and characteristics of those parts of the structure which are giving good service with the characteristics and properties of those which are failing in service is the most satisfactory method of approach; but still it is probable that the study of failures gives the most positive information.

During the past few years there has been some disintegration of concrete structures along the lines of the Lackawanna R.R. Similar reports have been received from other lines throughout the United States, as well as from other large consumers of cement. An examination as to the probable cause of the failure of these concrete retaining walls, bridge abutments, tunnels, etc., first led the Lackawanna R.R. to the conclusion that portland cement as being manufactured today does not meet all the requirements for such structures. If this be true, the question of the use of concrete at once becomes a matter of serious consideration for large consumers of cement.

It has often been hinted that there are engineers who would be quite willing to put the whole burden of concrete failures on the cement manufacturer, and on the other hand it is quite certain that the cement makers have again and again washed their own hands entirely of the responsibility in this matter and have claimed that it was simply a question for the inspectors and the engineers. We do not understand that the manufacturer of any material for the use of public-service corporations can assume an air of indifference.

A careful examination of the failures noted has led us to believe that they should be classified as follows:

(1) Failures due to the use of inferior grades of sand and stone and badly mixed concrete or insufficient water to permit the concrete to attain its full strength.

(2) Failures due to

(a) Placing concrete during the winter months and allowing the material to become frozen before the concrete has attained its final set;

(b) the use of calcium chloride;

(c) the placing of concrete in very hot weather when the temperature of the water is around 90 to 100°, the cement at the same time being improperly seasoned, with the result that the cement gets an initial set in the mixer and is thereby broken when placed in the work.

(3) Failures due to green and unseasoned cement and improperly manufactured material.

This analysis will show that it is our opinion that a great number of the failures are due to mechanical incompetency. From the past history of concrete there is good reason to believe that if portland cement is properly manufactured, the proper kind of aggregate used and the work properly done, structures built of concrete will be reasonably permanent. We have, however, considerable evidence to the contrary. We have knowledge of a number of structures built under the best conditions of workmanship and with the closest observation of standard tests where the structure after some three years of successful life begin to show marked signs of deterioration. It is to be presumed that the cement placed in these structures was fully up to the standard specifications in vogue at that time, since most of the material came from reliable mills which had been manufacturing cement for a number of years. The only conclusion as to the failure then is that there was some hitherto unknown fault in the cement itself. In two or three cases the cement used failed on the regular boiling test but a recent examination of the work shows that these structures are failing badly. This cement, of course, would have been condemned had it been tested and examined in the regular way and the failure of the structure built from it is of no interest in this connection.

The statements above as to the failure of the structures are made with full knowledge of the recent investigations of the effect of alkali and electrolysis on concrete work. The failure of concrete in the Central and Far West has been quite thoroughly investigated by various experimenters who have clearly pointed out that some failures in that part of the country are due to the action of alkali. Failures in such states as New York, Pennsylvania and New Jersey surely cannot be attributed to these elements. The theory of electrolysis in concrete has been advanced by one or two investigators, but to date no substantial proof has been offered which would in any way be conclusive that failures in mass concrete have been due to this cause. In many cases where failure has occurred there was no electric current present in the immediate neighborhood of the concrete bridge or abutment; yet the failures in these cases appeared very similar to others wherein a few tenths of a volt was detected at various times.

The studies of the question then led us to an investigation of the boiling test for cement. Very close inspection and tests on each car of cement used by the Lackawanna or any of its contractors have been conducted now for the past three years. A number of cars of cement from time to time from various mills have been rejected on account of failing to pass the ordinary boiling test. Other samples of cement which appeared to pass this test satisfactorily gave evidence through their general behavior on undergoing special tests that the cement was not of the best material.

Samples of cement which failed on the ordinary boiling test, after being kept in the laboratory for a few days would apparently pass this test satisfactorily. As to the probable cause for this sudden change in the cement, present technical literature fails to offer any satisfactory explanation and it appeared evident that before we could expect to make rapid progress along the line of cement investigation this question would have to be answered. Various investigators claim that the failure of cement on ordinary boiling tests is due to a certain percentage of free lime and that seasoning the cement for a few days would eliminate this free lime and cause the cement to satisfactorily pass the boiling test. It appeared reasonable to us that if the cement was subjected to a higher temperature and pressure than given in the ordinary boiling test it should still remain sound if it were a good cement. With this idea in view the laboratory at

TABLE I. TESTS ON CEMENT FROM MILL NO. 1

Date	Mark	Boiling test 1-atmos.	Tens. str. 24-hr. lb. sq. in.	Ten. str. 20 atmos. lb. sq.in.	Ten. str. per cent. of increase or decrease	Per cent. water absorbed 20 atmospheres	Per cent. expans. 1x2 in. 20 atmospheres	Fineness 100 mesh per cent.	Fineness 200 mesh per cent.
10-26-11	2	O.K.	333	567	70.2 (I)			94.5	79.3
10-28-11	4	"	308	753	144.7 (I)			94.6	78.0
10-30-11	5	"	284	315	10.9 (I)			94.9	80.4
10-31-11	6	"	272	517	90.0 (I)			94.4	77.1
10-31-11	7	"	265	243	8.3 (D)			94.0	78.9
11- 6-11	8	"	232	Wt.Pcs.				94.8	79.5
11- 8-11	9	"	252	"	....	not taken	not taken	94.5	79.4
11- 9-11	10	"	346	"	....			94.8	78.5
11-14-11	11	"	176	"	....			94.8	78.4
11-16-11	12	"	239	"	....			94.8	79.5
11-16-11	13	"	253	"				94.9	79.4
11-24-11	14	"	268	508	89.5 (I)			94.8	76.7
1- 9-12	15	"	297	65	78.1 (D)			95.2	78.1
1-13-12	16	"	350	Wt.Pcs.	....			94.8	79.3
2-11-12	17	"	295	"	....			92.9	72.2
3- 5-12	18	"	336	"	....		8.70	94.3	77.4
3- 9-12	19	"	261	"	....		4.40	93.9	78.8
3-22-12	20	"	295	"	....		8.40	91.9	73.1
3-27-12	21	"	368	"	....			93.5	75.5
5-20-12	22	"	341	42	87.7 (D)		5.95	95.0	80.4
5-23-12	23	"	286	50	80.4 (D)	5.24	4.45	94.2	79.7

Scranton introduced the so called "autoclave" test for cement and for the past year investigations have been carried on with this apparatus, with the result that the specifications for cement to be used by the Delaware, Lackawanna & Western R.R. must now pass the autoclave tests.

Description of the Autoclave Test

This test is carried on as follows:

Neat briquettes are made up in the regular way and after being in the moist closet for 24 hr. are placed in an autoclave* and well covered with water. Steam pressure is raised to 285 lb. per sq.in., about 20 atmospheres, the time necessary to raise the pressure to this amount being about three-quarters of an hour. The pressure is then maintained for 1¼ hr. longer, or a total time of 2 hr. The autoclave is then blown off and the briquettes removed (where their condition permits) and as soon as cool are broken in the standard cement-testing machine. The results obtained in this test are surprising, some cements showing a large increase in tensile strength and others completely going to pieces. Those pieces that come out perfectly sound are considered to have passed the test. The laboratory has kept a complete record of all its work in this line and from this record we have deduced several facts.

*A strong metallic vessel, gas tight when closed, used for heating liquids under pressure.

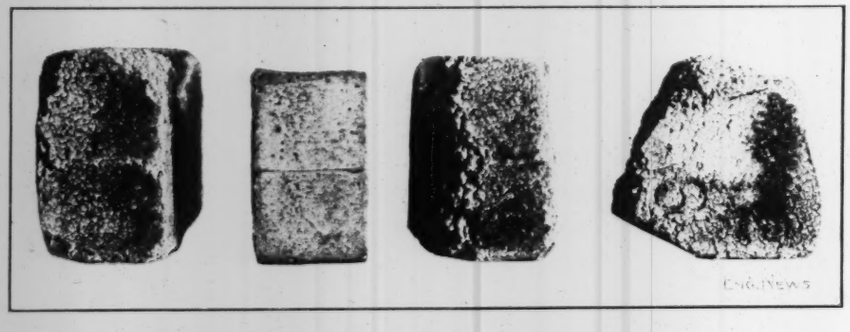

Fig. 1. Briquettes from Mill No. 1 After Autoclave Test

(Second briquette from left passed test; others failed.)

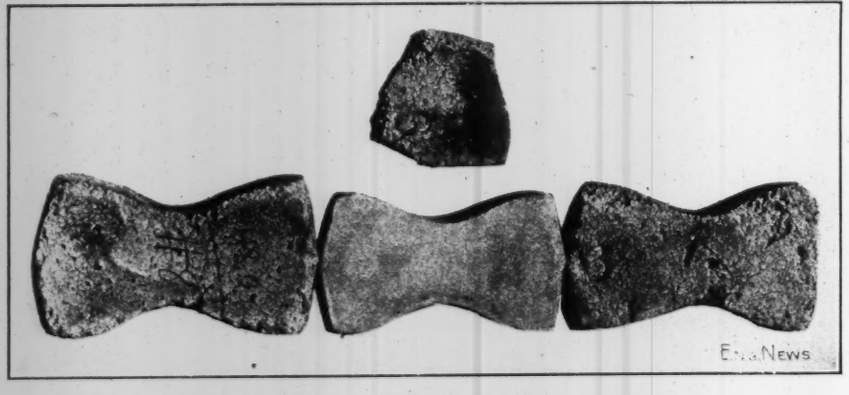

Fig. 2. Another View of Briquettes Shown in Fig. 1

Results of Tests

We give below the results of tests on cement from six different mills. These results are all tabulated in the same manner and give the date of the individual test, the behavior of the test piece under the ordinary one-atmosphere boiling test, the tensile strength at the end of 24 hr. in free air (the regular specification test), the tensile strength after being submitted to 20 atmospheres pressure in the autoclave, the increase in tensile strengths, the percentage of water absorbed by the briquette after being submitted to 20 atmospheres, the expansion of a 1-in. by 2-in. test piece (made for the purpose) after being submitted to a 20-atmosphere pressure and finally the fineness through a 100- and a 200-mesh sieve. Each test figure in these tabulations represents at least one carload of cement and in a few cases as many as eight carloads. In all, the tests cover several hundred carloads.

Mill No. 1—It will be noted (Table I) that on Oct. 26, 28 and 30, shipments from this mill showed an increase in tensile strength as compared to those broken at the end of 24 hr. of from 10 to 144%, while one car (marked No. 7) showed a decrease of 8.3%. From that date until Nov. 24, the cement completely went to pieces in the autoclave test. On Nov. 24, the shipment showed an increase in tensile strength on the autoclave test of 89½%, while on Jan. 9 a decrease of 78.1% in tensile strength is shown: From Jan. 13 to March 27, 1912, all shipments from this mill went completely to pieces. On May 23, sample No. 23 of this cement pulled 50 lb. after coming out of the autoclave test. The briquette absorbed 5.24% of water and had an expansion of 4.45%.

Many of the briquettes when removed from the autoclave were badly swollen and cracked. In many of these briquettes it was impossible to get a percentage of water absorbed as portions of the briquette had fallen off in the autoclave test. Like results occurred on some expansion bars* in a few cases. This is perhaps better shown by the photograph of briquettes from Mill No. 1 (Fig. 1). This photograph shows two full briquettes removed from the autoclave test badly swollen and cracked, and also one briquette which had passed the autoclave test from the same mill and which appeared to be perfectly sound. At the right is the piece of a briquette which failed. These briquettes when removed from the autoclave are very soft, but after drying out they assume a granular condition. Many persons who have examined these and similar briquettes, at first sight believe them to be sand briquettes, but on closer examination, however, they discover that they are neats. This photograph is a

*Expansion bars are 1 in. sq. x 2 in., bars made of neat cement. (See bars in Fig. 3.)

TABLE II. TESTS ON CEMENT FROM MILL NO. 2

Date	Mark	Boiling test 1-atmos.	Tens. str. 24 hr. lb. sq. in.	Ten. str. 20 atmos. lb. sq.in.	Ten. str. per cent. of increase or decrease	Per cent. water absorbed 20 atmospheres	Per cent. expans. 1x2 in. 20 atmospheres	Fineness 100 mesh per cent.	Fineness 200 mesh per cent.
10-19-11	2	O.K.	315	120	61.9 (D)			93.9	75.8
11- 1-11	3	"	236	185	21.6 (D)			94.1	75.6
11- 3-11	4	"	200	445	122.5 (I)			93.6	75.7
11- 4-11	6	"	248	432	74.2 (I)			93.5	75.7
11- 8-11	7	"	241	363	50.6 (I)			94.3	76.3
11-13-11	8	"	267	501	87.6 (I)			94.2	75.9
11-15-11	9	"	231	532	130.7 (I)			93.7	75.4
11-17-11	10	"	259	424	63.7 (I)	not taken	not taken	94.4	76.5
11-17-11	11	"	265	373	40.7 (I)			94.4	76.4
11-18-11	12	"	323	482	49.2 (I)			94.1	74.2
11-23-11	13	"	306	421	37.5 (I)			93.3	75.4
11-27-11	14	"	296	462	56.0 (I)			94.0	75.6
12- 5-11	15	"	287	514	79.1 (I)			94.5	75.4
12- 8-11	16	"	263	490	86.3 (I)			92.8	75.4
12- 9-12	17	"	240	586	144.1 (I)			94.4	75.0
12-16-12	18	"	218	181	17.0 (D)			92.6	75.0
12-16-12	19	"	331	205	61.4 (D)			93.5	75.8
3-28-12	20	"	369	517	40.1 (I)			93.9	75.8
4- 1-12	21	"	347	469	35.1 (I)		0.20	94.2	76.3
4-10-12	22	"	287	433	50.8 (I)	3.10	0.65	94.0	77.1
4-11-12	23	"	307	438	42.6 (I)	0.86	0.45	94.0	76.5
4-16-12	24	"	297	443	49.1 (I)	1.47	0.46	94.0	76.0
4-19-12	25	"	280	400	42.8 (I)	3.74	0.25	95.0	76.0
5- 1-12	26	"	308	Wt.Pes.	....	....	....	95.6	75.4
5- 2-12	27	"	282	"	....	....	....	93.8	75.6
5- 6-12	28	"	351	26	92.6 (D)	....	....	95.0	76.0
5- 8-12	29	"	301	Wt. to Pes.	....	9.57	5.84	94.0	76.0
5-13-12	30	"	323	165	48.6 (D)	3.25	2.58	95.4	76.6
5-15-12	31	"	243	68	72.0 (D)	9.03	3.01	94.6	75.8
5-16-12	32	"	310	52	83.2 (D)	9.15	4.31	94.5	75.3
5-18-12	33	"	340	55	83.8 (D)	8.40	5.06	94.0	76.0
5-22-12	34	"	314	167	45.8 (D)	7.01	2.14	97.0	78.0

striking illustration of several hundred briquettes and all show similar appearances from the various mills.

Fig. 2 shows the same briquettes from a side view. The reader will note the excessive expansion of the two end briquettes as compared to the one in the center.

MILL NO. 2—The results given on Mill No. 2 are perhaps very much more interesting than those given on Mill No. 1. They are shown in Table II. The details of the tests on the products of this mill are as follows:

From Oct. 19 to Nov. 1 the autoclave test showed a decrease on this cement, while from Nov. 3 to Dec. 9 an increase in some cases of 144% was noted. Careful inquiry as to the kind of cement this mill was furnishing showed that the cement which was being shipped was taken from the stockhouse. This cement had probably been seasoned for several months. Under date of May 1, the cement was furnished from a different stockhouse, it being perhaps from one to three weeks old. Samples of cement from this mill dating from May 1 to the present date lead us to believe that this material is improperly seasoned. Much of the cement when being received on the work was extremely hot. The cement was tested in the autoclave and results show it mostly went to pieces. The percentage of water absorbed was excessive, being as high in some cases as 9½, and the expansion in one case running up to 5.8%.

MILL NO. 3—This mill (Table III) varies considerably as to the kind of cement being shipped; one lot showing an increase in tensile strength on the autoclave, another lot going almost entirely to pieces.

MILL NO. 4—Cement from Mill No. 4 (Table IV) had in a majority of cases a fairly good increase in tensile strength. In two cases the briquettes went entirely to pieces.

MILL NO. 5—One of the most interesting cements is that from Mill No. 5. It will be noted that when the autoclave was first started on this cement (Table V) the first two shipments went entirely to pieces. A complaint was made to the mill with the result, as indicated in Table V, that all cement since shipped from this mill has passed the autoclave test.

A record of the cement from this mill shows that to date every shipment of cement has shown a large increase in tensile strength on the autoclave test. Attention is called to the small percentage of water absorbed and the small percentage of expansion.

The photograph from Mill No. 5 (Fig. 3) shows two briquettes made Oct. 28 and one briquette, the center one, made on Oct. 31. At the same time the two earlier briquettes were made up a number of others were made up and placed in the autoclave, but they failed so badly that it was almost impossible to remove them from the apparatus. Briquettes made simultaneously with the center one passed the autoclave test the day after their manufacture.

The two outside briquettes shown in Fig. 3 were placed in a tank of water for some few days and then exposed to the weather during the winter season; the center briquette was placed in the tank for a few weeks and then exposed to the weather during the winter season. It was thought possibly that when the cements were made up and exposed to the elements there would be an improvement in the quality of the briquette, at least we were so advised by one manufacturer. The briquettes were recently given the autoclave test. As the photograph shows, there was little improvement in the cements which failed on the autoclave test in October, while the cements which satisfactorily passed the autoclave test during the latter part of October and November are still apparently good and sound today after passing the autoclave test. The cracks on the two outside briquettes in many cases extend nearly through. The writer has noticed at various times concrete work which looks very much like these two outside briquettes and no doubt many who read this paper can recall similar appearances in concrete structures.

MILL NO. 6—Every single shipment from Mill No. 6 (Table VI) showed a large increase in tensile strength in the

TABLE III. TESTS OF CEMENT FROM MILL NO. 3

Date	Mark	Boiling test 1-atmos.	Tens. str. 24 hr. lb. sq. in.	Ten. str. 20 atmos. lb. sq.in.	Ten. str. per cent. of increase or decrease	Per cent. water absorbed 20 atmospheres	Per cent. expans. 1x2 in. 20 atmospheres	Fineness 100 mesh per cent.	Fineness 200 mesh per cent.
10-28-11	1	O.K.	353	687	94.6 (I)			95.8	83.5
11- 4-11	2	"	235	Wt.Pes.				96.7	84.2
11- 6-11	3	"	291	328	12.7 (I)			98.3	87.7
11-13-11	4	"	313	55	82.4 (D)	not taken	not taken	97.1	84.2
11-15-11	5	"	233	545	133.8 (I)			96.7	84.6
11-22-11	6	"	306	Wt.Pes.				96.4	80.4
11-24-11	7	"	306	178	41.8 (D)			95.6	78.9
12- 4-11	8	"	326	Wt.Pes.				96.4	80.3
12-16-11	9	"	304	"				96.7	79.6
12-28-11	10	"	297	"				96.2	81.5
2-26-12	12	"	236	"				95.3	77.6
4-10-12	13	"	300	"		9.05	4.0	95.0	78.2
5- 1-12	14	"	306	"				95.0	78.8
5- 6-12	15	"	315	"				95.0	81.6

TABLE IV. TESTS OF CEMENT FROM MILL NO. 4

Date	Mark	Boiling test 1-atmos.	Tens. str. 24 hr. lb. sq. in.	Ten. str. 20 atmos. lb. sq.in.	Ten. str. per cent. of increase	Per cent. water absorbed 20 atmospheres	Per cent. expans. 1x2 in. 20 atmospheres	Fineness 100 mesh per cent.	Fineness 200 mesh per cent.
10-28-11	1	O.K.	316	591	87.0			94.7	76.7
11- 1-11	2	"	256	597	109.7			94.1	79.1
11- 8-11	3	"	213	511	139.9			95.0	80.2
11-22-11	4	"	245	479	95.5	not taken	not taken	94.9	76.3
12- 7-11	5	"	183	Wt.Pes.				96.8	83.6
12- 7-11	6	"	204	229	7.35			97.2	84.8
2-20-12	7	"	201	349	73.6			94.7	78.9
3-11-12	8	"	288	Wt.Pes.			4.80	95.5	80.8
4- 2-12	9	"	191	337	76.4		0.65	94.9	79.7
4-12-12	10	"	247	431	74.5	0.40	0.25	94.1	80.6
4-17-12	11	"	283	303	7.0	1.18	0.37	95.0	80.0
4-29-12	12	"	91	107	17.5	3.62	2.01	94.9	79.7
5- 3-12	13	"	255	253		2.62	0.30	95.0	79.6
5-17-12	14	"	313	382	22.04	1.43	0.35	95.2	82.4

autoclave test. Investigation developed the fact that this cement was at least six months old.

Analysis of Tests

To those who are large users of cement, the figures from the above tables will be worthy of study.

The question naturally arises as to why a cement which passes the ordinary boiling test in many cases goes entirely to pieces or shows a considerable falling off in tensile strength when placed in the autoclave test. Samples of cement which failed on the autoclave test have been held in the laboratory and retested after a period of two months. In many cases we found the cement after this period of time to meet the requirements of the autoclave test. If we are to take the opinions of the various investigators, it would appear that a cement which would satisfactorily pass the ordinary boiling test could not contain free lime; yet when the same cement was placed in the autoclave test the material at times became very soft and crumbly, showing a large amount of swelling. It would seem from this that the ordinary test would be sufficient to thoroughly slake any free lime which might be present, and a sample of cement which would pass the ordinary boiling test could also, if the free lime had been eliminated, pass the autoclave test, but this does not appear to be the case. We believe that we are quite safe in saying that the failure of the cement to pass the high-pressure test, or a sample to fail in the ordinary boiling test, it not due to free lime.

If free lime were the cause of the cement failing on the ordinary boiling test, then the holding of the sample a few days in the laboratory must necessarily produce certain changes. The free lime must absorb a certain percentage of water or a certain percentage of carbon dioxide, forming in one case calcium hydrate and in another case calcium carbonate.

Careful chemical analyses on samples which have failed on the autoclave test and which passed it satisfactorily a little later on, shows that the percentage of carbon dioxide absorbed during this period is about 0.2% and that the percentage of moisture absorbed during this period is from 0.2% to 0.4%. It appears quite evident that had there been any appreciable amount of either free lime or free magnesia present in the cement we would expect to get a much larger amount of carbon dioxide or moisture.

The theory has been advanced by one investigator that the failure may be due to one of the silicates. He states that one of the silicates may change from tricalcium silicate to monocalcium silicate or some other silicate in this short period of time. Of course, if this could be proved it would no doubt be very interesting.

Dr. H. E. Kiefer has pointed out that the probable cause of failure is due to the coarser particles of the cement; these particles inclosing free lime, the outside of the granules being composed mostly of silica. If this were the case then the coarser particles of the cement would no doubt contain more lime than the finer particles. Following out this idea, a sample of cement was taken which failed on the high-pressure test and all the coarse material which failed to pass the 200-mesh sieve was removed. The coarse material and the fine material were then carefully analyzed for calcium oxide, the analysis showing the fine material to contain 62.2% of calcium oxide and the coarse material to contain 62.22% of calcium oxide, there being practically no difference as to the percentage of lime in either the coarse or the fine material.

Samples of cement were taken and treated to an excess of a normal solution of acetic acid. After standing three hours, the excess of acid was neutralized by a standard alkali and it was discovered that the cements which failed on the autoclave test took a smaller percentage of acid to neutralize the total alkali in the cement than the samples which passed the autoclave test, thus proving that the total amount of alkali which would repeatedly combine with the acid is no greater in a sample of green cement than it is in a sample of thoroughly seasoned material.

If our theory is correct, the failure to pass the ordinary boiling test as well as the high-pressure test is due to a certain kind of coarse granules in the cement, and the seasoning, together with the action of temperature and moisture, should break up these granules or cause them to become fractured so that when placed in a solution of acid we would obtain a higher percentage of alkalies which would combine with the acid. This is about what we usually find in various cements.

It appeared very evident that the coarser granules of the cement, that is,

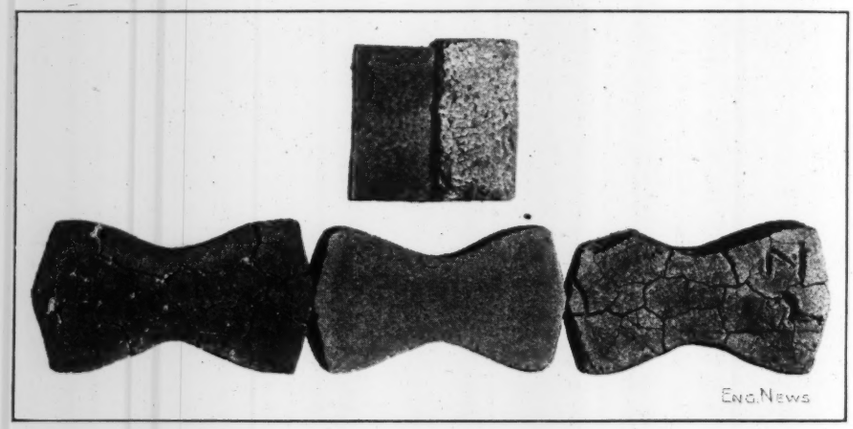

Fig. 3. Specimens from Mill No. 5

(Outer two briquettes failed under autoclave test; center one passed. Left expansion bar passed; right expansion bar failed. Note difference in size of two expansion bars which were originally same size.)

TABLE V. TESTS OF CEMENT FROM MILL NO. 5

Date	Mark	Boiling test 1-atmos.	Tens. str. 24 hr. lb. sq. in.	Ten. str. 20 atmos. lb. sq. in.	Ten. str. per cent. of increase or decrease	Per cent. water absorbed 20 atmospheres	Per cent. expans. 1x2 in. 20 atmospheres	Fineness 100 mesh per cent.	Fineness 200 mesh per cent.
10-19-11	3	O.K.	365	Wt.Pes.				94.7	75.8
10-28-11	5	"	321	"				94.5	76.8
10-31-11	6	"	284	859	202.4 (I)			96.4	80.0
11- 6-11	7	"	278	741	166.5 (I)			96.0	77.8
11-13-11	9	"	247	625	153.0 (I)			96.0	80.0
11-23-11	11	"	339	716	111.2 (I)			95.3	76.2
12- 4-11	12	"	282	688	143.9 (I)			95.2	77.7
12- 8-11	13	"	292	633	116.5 (I)			93.6	75.2
12-13-11	14	"	258	489	89.5 (I)			93.3	73.3
12-16-11	15	"	321	595	85.3 (I)			95.8	77.9
1- 1-12	17	"	254	629	147.7 (I)	not taken	not taken	94.2	75.0
1-11-12	18	"	262	550	150.0 (I)			96.2	78.0
2- 1-12	19	"	262	514	96.1 (I)			95.4	77.7
2- 9-12	20	"	281	555	97.5 (I)			95.5	78.7
2-21-12	21	"	329	722	119.4 (I)			96.8	80.0
2-26-12	22	"	214	715	234.1 (I)			97.9	82.1
3- 2-12	23	"	294	591	101.0 (I)			97.1	83.0
3- 8-12	24	"	312	695	122.7 (I)		0.20	96.6	81.6
3-15-12	25	"	407	673	65.3 (I)	2.50	0.05	96.3	80.6
3-25-12	26	"	323	575	78.0 (I)	0.82	0.00	97.1	79.8
3-27-12	27	"	381	633	66.1 (I)	1.70	0.00	97.1	79.5
3-28-12	28	"	376	646	71.8 (I)	1.37	0.05	96.6	77.9
4- 1-12	29	"	344	624	81.4 (I)	....	....	97.2	81.3
4- 5-12	30	"	354	690	94.9 (I)	0.89	0.10	97.9	84.8
4-16-12	31	"	315	540	71.4 (I)	1.03	0.20	95.0	78.6
4-19-12	32	"	316	590	83.5 (I)	2.04	0.05	95.0	81.0
4-23-12	33	"	393	533	35.6 (I)	1.10	0.15	94.8	77.0
4-30-12	34	"	311	563	81.0 (I)	1.25	0.10	94.0	77.0
5- 6-12	35	"	336	515	53.2 (I)	1.57	0.15	95.0	80.0
5-18-12	36	"	355	608	71.2 (I)	2.03	0.10	95.0	80.0
5-23-12	37	"	361	572	58.4 (I)	....	0.20	97.8	80.7

TABLE VI. TESTS OF CEMENT FROM MILL NO. 6

Date	Mark	Boiling test 1-atmos.	Tens. str. 24 hr. lb. sq. in.	Ten. str. 20 atmos. lb. sq.in.	Ten. str. per cent of increase	Per cent. water absorbed 20 atmospheres	Per cent. expans. 1x2 in. 20 atmospheres	Fineness 100 mesh per cent.	Fineness 200 mesh per cent.
11-4-11	1	O.K.	210	676	221.9 (I)			97.9	86.2
11-17-11	2	"	286	724	153.1 (I)	n.t.	n.t.	98.2	85.3
11-18-11	3	"	269	603	123.0 (I)			97.3	84.1
5-10-12	4	"	393	533	75.9 (I)	0.87	0.10	94.5	79.2

the material which fails to pass the 100-mesh sieve and a portion of the material which fails to pass the 200-mesh sieve were responsible for the cements failing on the autoclave test. When a sample of cement is set up with water these hard granules, which are probably portions of the hard-burnt clinker, do not become thoroughly moistened, only the surface being affected. When briquettes containing granules of this nature are made up and placed in the autoclave and are submitted to high pressure and temperature together with moisture, the pressure and heat disrupt or break up the granules and the cement then comes in contact with the water, with the result that the briquettes greatly swell and expand and absorb a corresponding percentage of moisture.

In order to test this theory more fully an investigation was made of a cement from Mill No. 2 (sample No. 29, Table II). In the first test (Table II) this sample pulled 301 lb. at the end of the regular 24-hr. test, but went to pieces in the autoclave test, the briquette absorbing then 9.57% of water. Further investigations of this cement are tabulated in Table VII.

TABLE VII

Conditions (as noted in text)	Tens. str. 24-hr. regular test	Tens. str. 20 atmos.	Water absorbed
	lb per sq.in.		%
A	240	80	6.08
	267	79	5.85
B	252	423	1.76
	274	427	1.60
C	285	352	3.52
	260	311	2.89

Test A (Table VII) was made on an ordinary sample of this cement. Test B is upon a sample from which only the material passing a 200-mesh sieve was used. Test C is upon a sample in which the cement was reground so that all material would pass a 200-mesh sieve. The results on this sample of cement are exceedingly interesting. It will be noted that on the autoclave test, as the material is received, we get 80 lb. while simply removing all the material which failed to pass the 200-mesh sieve gave 423 lb. and 427 lb., while in the other case where all of the material was ground to pass the 200-mesh sieve very good results were obtained in the autoclave test. It is exceedingly interesting to note the decrease in the percentage of water absorbed by the briquettes when all of the coarse material was removed. In the case where the coarse material was ground to pass the 200-mesh sieve, we have an increase in the water absorbed over that in which all of the coarse material was removed entirely, thus showing that in the autoclave test with the high temperature and pressure these granules are broken up in the cement which did not come in contact with the water at the time the cement was set.

To test the repeated action of cement in the autoclave the results shown in Table VIII were obtained from samples taken from Mill No. 4 and Mill No. 6. These two samples were probably six months old when subjected to the autoclave test. It will be noted that on the autoclave test at 20 atmospheres for two hours we obtained, on No. 6, 629 lb. In making this test a number of briquettes were made up; in this case 12 briquettes were used, all being placed in the autoclave and tested for 2 hr. Three briquettes were then broken, the other nine briquettes were placed again in the autoclave the following day, and after the test was complete three briquettes were taken out and broken. This was repeated until the entire 12 had been tested.

It will be noticed that on the second day after the cement had had 4 hr. at 20 atmospheres there was a decrease on Mill No. 6. It will be noticed that on Mill No. 4 there was still an increase on the second-day test but a decrease on the third-day test, after the cement had been tested for 6 hr. at 20 atmospheres. On both Mills Nos. 4 and 6 the briquettes show a higher tensile strength after 8 hr. test at 20 atmospheres than the material showed after 24 hr. in air.

We fail to see how a cement which would completely go to pieces in the autoclave test in less than 2 hr. can be compared with other cements which show a decided increase under that test in the same period of time, and after testing of 8 hr. still show a higher tensile strength. Certainly a cement which is constant in volume should show no decrease in tensile strength in the autoclave test, but should at least show an increase of 25% in tensile strength; that is, if we expect a material which will be constant in volume.

The chemical analyses on cements tested from the various mills show the composition to be about normal for the regular portland cements. The tests for 7 and 28 days and longer periods seem to show better results for cement passing the autoclave test, but to date sufficient data are not at hand to show a comparative increase between the various brands of cement.

Conclusions

It is recommended that all shipments of cement should be carefully tested to the standard specification and that the autoclave test is offered as an additional safeguard. Cement which meets all of these requirements will, we believe, make a sound and lasting concrete.

It is not believed that the autoclave test alone will be able to judge the quality of portland cement, but we do believe that the autoclave test will show whether or not the cement contains an excessive portion of coarse granules which do not break up or become hydrated when the water is added to the cement for the setting of the material.

From our experience it is our opinion that engineers desiring cement which will meet all the requirements of the autoclave test will experience no difficulty in obtaining it if it is insisted upon.

The writer believes that it is necessary that the raw material be finely ground, the temperature of burning be properly regulated, and that the cement be properly seasoned.

It appears from this investigation that the failure of cement to pass the ordinary boiling test or the autoclave test is due to the coarse granules of cement, for when they are more finely ground a greater portion of them becomes thoroughly moistened in the setting process and so do not tend to cause the briquettes to disintegrate in the autoclave test.

We believe that like conditions occur in the ordinary boiling test. As a rule, the more finely the cement is ground the better will be the chances of the material passing not only the ordinary boiling test but the autoclave test as well. If we are to obtain briquettes or pats which will be constant in volume cements which are more coarsely ground must receive more seasoning in order to give the granules a chance to become fractured so that moisture may penetrate these granules when the cement is set up.

It appears very probable that if cement which fails on the high-pressure test but which has passed the ordinary boiling test is placed in certain structures it must necessarily still contain a large number of granules which did not at the time the concrete was placed be-

TABLE VIII. EFFECT OF REPEATING AUTOCLAVE TEST ON SAMPLE

(Tensile strength, lb. per sq.in.)

Mill	Average tensile strength in air	Average tensile strength 20 atmospheres 2 hr.	Average tensile strength 20 atmospheres 4 hr.	Average tensile strength 20 atmospheres 6 hr.	Average tensile strength 20 atmospheres 8 hr.
No. 6.....	346	629	512	461	414
No. 4.....	206	435	491	386	322

come moistened or which took no part in forming the true cement. If a cement of this kind is placed in a structure it appears entirely possible that in a few years moisture will work its way into the structure and these granules will in time become ruptured and so start expansion and disintegration of the concrete.

We believe that the white streaks so often noticed in retaining walls is due to the coarse granules of cement being broken up at various times, and coming in contact with water would at this period wash out the cement producing the white streaky appearance so often noticed in various structures.

It has been noticed at various times that where so called dry concrete was placed, after a period of a few years some of the work shows signs of failure and if our theory is correct then this is what we may expect. A large portion of the cement did not at the time receive sufficient water to form true cement with the result that in after years disintegration has taken place.

Summary

While the work on this subject is by no means complete, yet it represents the results of hundreds of tests. We may make the following summary:

First: Only the fine material of the cement enters into the reaction on the setting of the same.

Second: The coarser particles of the cement become fractured and broken with age and the disintegration of these particles or granules will assist the cement pasing the autoclave test.

Third: The failure of the cement to stand the ordinary boiling test or the autoclave test is not due to either free lime or free magnesia.

Fourth: Increasing the fineness of unsound portland cement improves its quality and if the material is fine enough the cement in every case becomes sound.

Fifth: The finely ground cements are more constant in volume and will usually show a considerably higher tensile strength on the sand briquettes, the difference sometimes being as much as 15% in favor of the finely ground material.

Visitors to the Panama Canal—The season in which the people from the United States and foreign countries visit the Canal in the greatest numbers is included in the dry months, namely, December, January, February, March and April. A larger number of people from the United States and abroad visited the Canal during the season of 1911-1912 than at any other time since the beginning of operations by the Americans. The record shows that February was the principal travel month, and during that month more ships docked at the ports of Cristobal and Colon than in any previous month in their history. The number was 103. About 95% of the total who landed at Colon or Cristobal were canal sight-seers.—"Canal Record."

Contamination of the Water Supply at Memphis, Tenn., by the April Mississippi Floods

By Paul D. Fuqua*

During the April flood of the Mississippi River, the city of Memphis suffered severely on account of the flooded condition of the northern parts of the city. The street-car service was impaired; the gas supply was cut off, and most serious of all, the public water supply in that part of the city was badly contaminated.

In order that the condition may be more clearly understood, a short description will be given of the city's water supply; the drainage in that part of the city in which the contamination occurred and the flood in the Mississippi River which was the direct cause of the contamination.

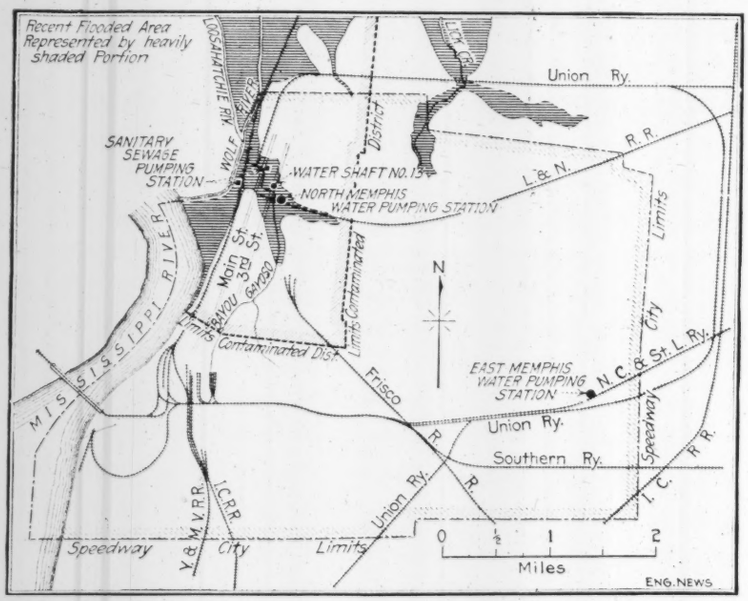

Fig. 1. Map of Memphis, Tenn., Showing Area Flooded in April, 1912 in Relation to Sewage Contamination of Portion of Water Supply

Memphis Artesian Water Supply

The water supply of the city of Memphis is derived from water-bearing sands of the La Grange formation lying some 400 or 500 ft. beneath the surface and directly beneath a layer of clay which protects it from surface water filtering through. Three distinct systems have been followed in developing the supply.

By the first system, established in 1888, the water is collected, through underground tunnels, at a central pumping station and pumped direct into the mains. This system, through which the contamination occurred, is described more fully in the following paragraph. By the second system, first established in 1908, the water is forced from the wells by compressed air to a central station and to within suction reach of the high lift pumps, by which it is forced under pressure into the mains. Two stations employing this system have been installed; one in East Memphis having a daily capacity of 6,000,000 gal. and one in New South Memphis having a daily capacity of 2,000,000 gal. By the third system, called the segregated-well system, centrifugal pumps are installed below the pressure (artesian) head of the water. These pumps, direct connected to motors at the surface, also discharge the water into the mains. Independent wells of this type are scattered over the residence section and have a combined daily capacity of approximately 5,000,000 gal. The second and third systems have been in no way contaminated. Before April 1, the average daily pumpage from wells of the second and third systems combined was 5,000,000 to 6,000,000 gal., or about one-third of the total pumpage. At present the daily pumpage from these wells has been increased to 13,000,000 gal.

The first system of wells established, which ordinarily delivers about 10,000,000 gal. daily, or two-thirds of the city's normal supply, is located in North Memphis, in and adjacent to the area flooded by back water. A total of 137 of these 8-in. and 10-in. wells have been driven which are tributary to the North Memphis pumping station. Of this number, 66 have been abandoned on account of the strainers at the bottom having become clogged. These wells cover an area of approximately 1000x2000 ft.

By natural pressure, the water is delivered from the wells to a system of 60-in. diameter tunnels whose combined length is about one mile. Car-

*Assistant Engineer Subway Construction, Joint Railroads, 681 Rayburn Boulevard, Memphis, Tenn.

rying the water from the individual wells to the trunk tunnels is a series of branch tunnels aggregating some three miles in length. This system of tunnels converges to a wet well at the North Memphis pumping station near the Bayou Gayosa where three 10,000,000-gal. daily capacity pumps have been installed, which deliver the water under pressure direct to the city mains. Only the water from this system of wells was contaminated during the recent flood.

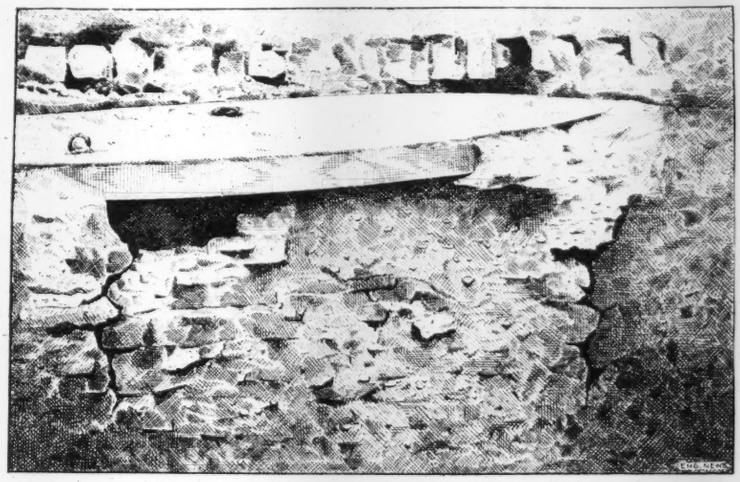

FIG. 2. SKETCH SHOWING CRACKS IN BRICK WALL OF WATER SHAFT NO. 13, MEMPHIS ARTESIAN WATER SYSTEM

(Redrawn from a halftone published in "The News Scimitar." The original illustration bore this note: "The water entered the surface of the ground through the cobblestone gutter on the west side, then flowed eastward and down to the opposite side of the shaft, entering through hole and two large cracks, from 18 in. to 4 ft. below surface.")

THE CITY'S DRAINAGE AND SEWERAGE

The storm water from the business district of the city is taken off through the Bayou Gayosa, which empties into Wolf River. Wolf River, flowing west, forms the northern boundary of the city and empties into the Mississippi River immediately above the city.

The sanitary sewage, from the business district containing approximately 90,000 people, flows into a collecting basin at the main sewage-pumping plant located at Main Street and Bayou Gayosa. This plant is equipped with two large centrifugal pumps which discharge the sewage into the bayou. A second sewage-pumping plant, equipped with one pump and connected with the collecting basin by means of a pipe line, is located on Wolf River and discharges into it.

By referring to the map of Memphis (Fig. 1) the relative location of the North Memphis pumping station, the Bayou Gayosa, Wolf River and the sewage-pumping plants will be better understood.

APRIL FLOOD IN THE MISSISSIPPI RIVER

Along the banks of the Bayou Gayosa, and at other low-lying portions of the city fronting on Wolf River, levees have been built up to an elevation corresponding to 42 ft. on the river gage. On April 2 the water in the Mississippi River reached this level and overflowed the levees, flooding the low-lying territory along the bayou on both sides, and stopping the operation of the sewage-pumping plants and the city gas plant. The North Memphis water-pumping station was protected by an independent concrete wall, the elevation of the top of which corresponds to 46.0 on the river gage. Fig. 3 shows this pumping station surrounded by the flood waters.

The water in the Mississippi River continued to rise, as may be seen from an inspection of the table of gage readings at Memphis for month of April, and reached a maximum stage of 45.3 on April 6 when the main line of the Mississippi River Levee on the west bank broke near Hollybush, ten miles above, and near Wyanoke, ten miles below, Memphis. These breaks caused the river to begin falling. Other breaks further up the river having the same effect, it continued to fall until it had reached a 42-ft. stage again on April 17. On the 30th, the gage read 36.8 ft.

GAGE READINGS TAKEN BY THE U. S. WEATHER BUREAU AT MEMPHIS, TENN., DURING THE MONTH OF APRIL, 1912, AT 7 A.M.

Date	Gage	Date	Gage
April 1	40.9	April 16	42.1
2	41.9	17	42.0
3	42.6	18	41.8
4	43.4	19	41.5
5	44.2	20	41.2
6	44.9	21	40.8
	45.3*	22	40.4
7	44.5	23	39.9
8	43.7	24	39.3
9	43.6	25	38.7
10	43.2	26	38.2
11	42.7	27	37.9
12	42.5	28	37.6
13	42.4	29	37.2
14	42.3	30	36.8
15	42.2		

*Maximum at 2 p.m., April 6.

THE CONTAMINATION AND HOW IT OCCURRED

From the above description, it is seen that from April 2 to 17, the flood was above the levees along the banks of the Bayou Gayosa and that the sewage from 90,000 population was pouring into the flooded area. From the 2nd until the 6th, none of the sewage could have reached the Mississippi River, since, with a rising river, the current was reversed in the bayou. As soon as the levees along the bayou were again exposed, pumps were put to work to unwater the flooded area adjacent to it. The period during which this section was flooded may be stated as three weeks.

When the system of main 60-in. diameter tunnels, lined with brick, and the smaller branch tunnels, lined with wood, were driven, shafts were sunk from the surface to facilitate construction and afford access to the tunnels to relieve the clogging of the strainers through which the water passes as it enters. These shafts were all inspected by the water department when it became evident that the section in which they were located would be flooded, and all of them were said to have been hermetically sealed.

On about April 1, there was a noticeable discoloration of the water in the downtown district. This increased on the 2nd and 3rd, causing the health department to collect samples of the water and analyze them. The analysis showed the water to be badly polluted. Further analysis of the water from every section of the city revealed the fact that only the water from the North Memphis pumping station was contaminated. The pressure at this station was accordingly cut down and the pressure in the other stations was raised as high as possible, causing the pure water to force the polluted water back into the principal business district, later known as the "Contaminated District," being bounded on the south by Pontotoc Ave. and on the east by Dunlap St. Valves separating the polluted supply from the pure water were then closed along the boundary lines of this district.

The people were promptly warned to boil all water drawn in the contaminated district before using it. Street sprinklers were put in service dispensing pure water in this district which was drawn from hydrants outside the district.

The local authorities, realizing the gravity of the situation, decided to employ an hydraulic and sanitary expert to inspect the facilities of the water department; locate the source of infection, and make recommendations as to disinfecting the mains and protecting the purity of the supply in future.

Acting on this decision, George W. Fuller, consulting engineer, of New York City, was employed. Mr. Fuller arrived in Memphis on Apr. 27 and took immediate charge of the situation. All assist-

ance possible was given him both by the board of health and the officers of the water department.

A close inspection of the water-works plant and facilities was made and only one positive source of pollution was found. This proved to be at Shaft No. 13, which is located on Third St. and within the flooded area. Several years ago, the grade of South Third St. at this point was raised with 8 in. of gravel in order that the street might serve as a part of the levee system. It is supposed that in rolling the gravel, the heavy road roller crushed the brickwork under the iron rim and cover on the street side of the shaft.

FIG. 3. THE NORTH MEMPHIS PUMPING STATION OF THE WATER WORKS OF MEMPHIS, TENN., SURROUNDED BY THE APRIL FLOOD OF THE MISSISSIPPI RIVER

(Gage, 45.3. Building in rear houses three 10,000,000-gal. pumps. Building in foreground is store and supply room. Note top of concrete levee wall, at gage elevation 46.0.)

The accompanying sketch, Fig. 3, shows the nature of the opening left in the shaft after the water had washed away the loose filling material from around it. Mr. Fuller estimated the area of the opening to be over 80 sq.in.

The sewage pollution ceased on Apr. 21, as is proved conclusively by the improved condition of the water inspected and analyzed; by the fact that there was a drop in the water level of the suction well at the pumping station while the pumps were running at a uniform speed, and the water surface in the river had fallen below the level of the opening in the broken shaft (40.5 ft. river gage).

SEEPAGE INTO THE TUNNELS

In his report to the board of water commissioners, Mr. Fuller states that, in his opinion, there is a connection between the water in the Mississippi River, with its local tributary Wolf River, and the water in the North Memphis well system, either through the so called Orange sands dispersed in the clay strata 30 to 80 ft. below the surface, or through the action of flood water scouring out the silt in deep pockets in the river bed and establishing a connection with the sands of the La Grange formation into which the wells are driven. In either case, this water is so thoroughly filtered that little anxiety need be felt as to its effect on the purity of the supply. Observations show that, from time to time, the daily pumpage at the North Memphis pumping station exceeds the supply drawn from the wells into the tunnel by from one to two million gallons. Whether this water is derived from the deep water bearing sands of the La Grange formation, rising around the well casings, and up through the overlying bed of clay and by seepage through the brick lining of the tunnel, or from other underground water under pressure seeping through this lining, is a matter not yet determined. It should be definitely determined, however, whether any surface water from the thickly inhabited area in which the wells are located reaches the tunnels and seeps through the lining. Mr. Fuller states that the indications are that surface water did not enter the tunnel by seepage at this time.

DISINFECTION AND HEALTH CONDITIONS

In his report, Mr. Fuller recommended that the water at the North Memphis pumping station be sterilized by the addition of 10 lb. of hypochlorite of lime to 1,000,000 gallons of water through the medium of a 1% solution, stating that the sterilizing chemical releases oxygen in a nascent state in such a way that all intestinal bacteria are killed. He further recommended that all of the water pipes be thoroughly disinfected by flushing them with the disinfected water until analysis showed the supply to be pure. The flushing to begin at the pumping station and extend outwardly in all directions until the entire contaminated district should be sterilized. These recommendations were promptly put into execution. The contaminated district was divided into eight flushing districts, and flushing was begun in that district in which the pumping station is located on April 30. The eighth district was pronounced pure by the Board of Health on June 3 and the contaminated district is no more.

In order to protect the people from typhoid fever and other intestinal diseases, the Board of Health followed up the receding waters by disinfecting the entire area which was flooded. Vaccination for typhoid was strongly recommended from the first and free vaccination has been administered to all applicants. Between 10,000 and 15,000 people had been vaccinated by the Board up to the first of June and fully as many more by other physicians. Although a large proportion of the city's population are negroes, only about 1500 of them have been induced to take the treatment.

The table on the next page gives the daily number of new cases of, and deaths from, typhoid as reported at the office of the Board of Health for the months of April and May, Sunday cases being reported on Monday:

Of the 28 deaths there shown, 18 were from the negro, and 10 from the white population.

These figures show that up to June 1, only 352 cases of typhoid have developed in a city whose population is some 180,000. Of this number, 80,000 to 90,000 live within the contaminated district and the others, living outside the district, were more or less exposed at their places of business, since the principal business district is located in the heart of the contaminated district. Comparing the Memphis situation with parallel conditions in other cities, Dr. Goltman, President of the Board of Health, stated that at Maidstone, England, with a similar contamination, 1900 cases of typhoid developed in 30 days out of a total population of 35,000 and at Plymouth, Penn., 1200 cases developed in 40 days out of a total population of 3500. Only prompt action by the Board of Health and the Officers of the Water Department, could have averted a serious epidemic in Memphis this year. The rapidly decreasing number of new cases being reported leads those in close touch with the situation to predict that a total number of 500 cases, chargeable directly to the contamination, will not be exceeded.

PROPOSED NEW LEVEES IN NORTH MEMPHIS

For the future protection of the city, it is imperative that the existing levees in North Memphis along the Bayou

TABLE OF TYPHOID CASES AND DEATHS APRIL-MAY, 1912, MEMPHIS, TENN.

Date April	New cases	Deaths	Date May	New cases	Deaths	Date May	New cases	Deaths
1	2	0	1	7	0	17	10	1
12	1	0	2	13	3	18	10	2
19	2	0	3	15	0	20	15	7
23	3	1	4	30	0	21	11	0
24	1	0	6	16	3	22	3	0
26	4	0	7	18	0	23	8	1
27	7	0	8	17	1	24	2	1
29	8	0	9	22	0	25	3	0
30	17	0	10	15	0	27	18	2
	—	–	11	17	1	28	4	1
April total,	45	1	13	15	1	29	0	0
			14	11	0	30	3	1
			15	18	0	31	1	1
			16	5	1			
						May totals,	307	27

Gayosa be raised or that a masonry dam be built across the mouth of the bayou with new levees running out at each end to high ground. In view of the fact that levee construction work all along the Mississippi River will be pushed forward with renewed energy both by the National Government and the several drainage districts, and that with the river confined to its channel, much higher flood stages may be looked for, it would seem unwise to build the new levees to withstand a lesser flood stage than 50 ft. The April flood of the present year would probably have reached 48 ft. had none of the levees above Memphis given away or been overflowed. With 2 ft. clearance above the top of the water at the 50-ft. stage, the tops of the levees would then stand at 52 ft., or 10 ft. above the existing levees along the Bayou Gayosa.

Should the plan of raising the existing levees be adopted, the grades of many of the principal streets would have to be raised and large areas filled in. The district is very thickly built up and the property damage incident to raising the street grades would be enormous.

Should the plan of building a dam at the mouth of the Bayou be adopted, culverts would be left in the dam for draining the bayou when the stage of the river was 40 ft. or less. The culverts would be provided with valves for locking out the river at stages above 40 ft., a low-lift pumping plant would be needed for raising the water over the dam while the valves were closed.

The Mississippi River Commission inspected the condition in North Memphis during the period in which it was flooded and Clarke S. Smith, Major Corps of Engineers, U. S. A., has submitted a report to the Chief of Engineers on the Memphis situation with estimates of cost for protecting the flooded area. This report has not been made public.

The National Government is being urged to make an appropriation of $250,000 for protection work here and it is anticipated that a bill making the appropriation will be introduced during the present session of Congress.

[For a fuller study of conditions on the Mississippi during the recent flood, the reader is referred to the article by A. L. Dabney in another part of this issue.—Ed.]

The Importance of Water Supply Inspection, as Illustrated by Enteritis and Typhoid Outbreaks at Rockford, Ill.

By Edwin O. Jordan*

There is now a widespread and well grounded feeling of uneasiness about the use for a public water supply of an unprotected and unpurified surface water. A knowledge of watershed conditions and some attempt to guard against possible sources of contamination are generally considered indispensable.

The conditions surrounding ground-water supplies are not always scrutinized so closely. This seems to be due in part to the generally good character of ground-water supplies, and in part to the fact that occasional or indeed frequent analyses not directed toward a specific end may give no clue whatever to possible sources of contamination. It is not safe to assume that when a water supply is found to be good it will always remain good or that a deep-well water once pronounced pure by an analyst is able to care for itself ever after. There is reason to believe that some ground-water supplies are so handled with respect to storage and distribution that danger of contamination may exist. The factors of danger may not become operative more than once in a decade, but when they do, swift disaster follows. Simple inspection of a water supply will sometimes show opportunities for "accident" or "carelessness" that may be eliminated: analysis of the water alone will often fail utterly to reveal the existence of any of these possibilities of danger.

A recent instance of the contamination of an originally good ground-water supply has come to the writer's attention in his investigation of an outbreak of typhoid fever at Rockford, Ill., occurring during January and February, 1912. The population of Rockford in 1910 was 45,401. This epidemic was ushered in by an outbreak of diarrheal disease on January 16 to 20, which affected about 10,000 persons. The cases of typhoid fever followed about two weeks later and numbered nearly two hundred, with 19 deaths. Investigation of every case of typhoid fever about which information could be obtained soon showed that milk supply could be excluded as a factor, since no milk route had a disproportionate number of cases in relation to the number of customers. Fly infection was likewise eliminated by the season at which the outbreak occurred, and contact infection could not be considered a primary cause in view of the distribution of cases and the extent and explosive nature of the outbreak.

The Rockford water supply is derived from deep wells sunk to the Potsdam and St. Peter sandstones. The quality of the water had always been considered excellent, and repeated analyses made by the State Water Survey had given no evidence of contamination. Analyses made a few days after the January outbreak of enteritis showed no deviation from the uniform high quality that had previously been observed. This was also the case with samples of tap water examined by the writer in February, 1912.

The date of the enteritis outbreak, Jan. 16 to 20, corresponded with the development of the mass of typhoid fever cases about two weeks later and pointed to Jan. 16 as a time when something unusual had occurred in connection with the water supply. Something had happened. A large factory fire, starting about midnight of Jan. 15, had caused an unusual demand upon the water system through the morning of Jan. 16. The demand was met in part by drawing upon a reservoir with a capacity of about 1,250,000 gal. located near the pumping station and used whenever the draft of water was for a time greater than the wells could supply directly. As a rule about 200,000 to 300,000 gal. were drawn from the reservoir daily between the hours of 7 a.m. and 3 p.m. and the same amount restored to the reservoir from the mains when the demand on the pumps slackened. Ordinarily the reservoir level is lowered by the forenoon demand from about 18.7 ft. to 13 or 14 ft.

On the morning of Jan. 16, after the heavy draft due to the fire, the reservoir level had been reduced to 6.6 ft. Then another event out of the ordinary occurred. One well to the Potsdam (1320 ft.), known as Peach St. Well No. 2 had not been in general use for a long time, had in fact not been drawn on since the summer of 1911, owing to certain operating disadvantages. On Jan. 16, beginning at 11:45 a.m., water was pumped from Well No. 2 for 10 hours. Examination of the well and its surroundings showed a singular condition. The water is raised by an "air-lift pump," strikes an iron umbrella over the mouth of the pipe and falls back into a pit some 13 ft. deep and 8 ft. wide, opening to the street level by a manhole. An outflow pipe is located

*Professor of Bacteriology, University of Chicago.

about 2 ft. above the bottom of the pit and through this the water flows by gravity to the pumping station. The pit is not impervious. The wall is only one brick thick and not all the bricks were in place at the time of our inspection. The large Peach St. sewer is only a few feet away, and the contaminated ground water enters the pit at times. In addition, the manhole to the street was provided with four openings about ¾ in. in diameter through which street drainage had free access to the pit. At one visit the water from melting snow in the street was seen running into the pit, which thus acts as a storm sewer. Colon bacilli were isolated by the writer from the water which at times was found filling the pit to a depth of several feet. The operation of Well No. 2, when such conditions prevailed, was bound to result in a considerable degree of contamination.

At the same time that the reservoir level was being drawn down to an unusual point and the contaminated water from Well No. 2 was being introduced into the system, still a third unusual factor was operative. The pumps were being speeded at something beyond their usual rate, and probably, though there are no exact records, for a longer period than usual. The suction well from which the water is pumped into the mains is pervious and allows free entrance of ground water and this condition has long been known. The usual level in the suction well ranges from 10 to 12 ft., but is not uncommonly reduced to 8 ft. or less when the pumps are working at high speed. The ground water in the neighborhood of the pumping station is highly contaminated.

The water-works are located on the banks of the sewage contaminated Rock River, and the large Peach St. sewer is not far away. The whole district near the pumping station is thickly sown with privies.

There thus seemed to be three possible ways in which the Rockford city water supply might have become contaminated on Jan. 16: (1) The reservoir, (2) Peach St. Well No. 2, (3) the suction well. Further investigation narrowed down the responsibility to the two last-named. Although it was possible that seepage into the reservoir might have occurred when the level was reduced to 6.6 ft. on the morning of Jan. 16, water was not again drawn from the reservoir until the forenoon of Jan. 17, therefore too late to be held accountable for the outbreak of enteritis in the night of Jan. 16-17.

It is impossible to fix the relative share of Well No. 2 and the suction well. Water from Well No. 2 could not have been introduced into the system under conditions as we observed them without carrying with it more or less contamination. Lowering of the water in the suction well will also inevitably draw in contaminated ground water, as shown by our analyses made at different depths and levels. When the suction well was pumped dry and allowed to stand 6 ft. of contaminated ground water seeped in overnight. Under the circumstances it is plainly impossible to apportion exact responsibility between these two factors: the suction well and Peach St. Well No. 2.†

The Rockford outbreak affords an illustration‡ of the inadequacy of water analyses to detect dangerous conditions surrounding a water supply. A number of examinations of the water by expert investigators prior to the outbreak and immediately succeeding it showed a water of excellent quality. Inspection of conditions, however, would have revealed at once several possible avenues of contamination, a reservoir surrounded by privies and allowing seepage under certain conditions; a well long unused but connected with the system in a strikingly dangerous fashion; a pervious suction pit admitting at times contaminated ground water freely; a number of connections of mains with a sewage-polluted river, designed for emergency use.§

Of these several factors the first and last appear to have had nothing to do with the 1912 epidemic. Under other conditions, however, they might have brought about a similar or greater catastrophe. Two at least of these possibilities seem to have been more or less widely known in Rockford, but it was hoped no harm would result. Fortunately the outbreak, although serious enough, was not so destructive as it would have been had the proportion of typhoid bacilli in the sewage been high. In the Mankato epidemic, although there were probably fewer enteritis cases (about half as many as in Rockford ?), there were 440 primary typhoid cases, as compared with about 200 in Rockford.

In conclusion it may be said that while there is perhaps nothing remarkably novel in the cause and general character of the Rockford epidemic, the necessity of examining all the features of a water supply is further emphasized by this occurrence. Analysis alone, not controlled or supplemented by inspection, may give no useful information, or may even mislead.

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†A detailed description of the outbreak will appear in the July number of the "Journal of Infectious Diseases (Chicago).

‡See also the report by Grover and Dole on the typhoid outbreak at Cedar Falls, Iowa (Eng. News, Mar. 21, 1912, p. 526).

§The possibility that river water was admitted to the mains at the time of the fire was carefully investigated, but with entirely negative results. Direct use of river water certainly did not occur in the period under consideration.

‖Jour. Infec. Dis., 1911, 9, p. 410; also see Eng. News, Feb. 11, 1909, and Oct. 5, 1911, for detailed information regarding the Mankato outbreak, which was caused by a peculiar case of contamination of an artesian well supply.

Tar Spraying of Macadamized Roads in the Borough of Wandsworth, England, which is part of the administrative county of London, is said to have effected great savings during the past few years. We take the following from editorial comments by the London "Contract Journal" (Mar. 20, 1912), on the recently issued report of the Metropolitan Committee on Paving:

The most striking feature of the year's return is stated to be the saving consequent on tar-spraying of macadam roads, alike in the cost of scavenging, watering, and maintenance, since its adoption. The report of the borough surveyor of Wandsworth is specially referred to in respect of this point. The figures are certainly remarkable. The cost of scavenging, maintenance, etc., in the year 1906-7, prior to tar-spraying, was £96,035 (including £7434 for new wood paving). In the following year the figure had declined to £83,985 (including £3067 for wood paving), and in the year 1910-11 (the year of the report) the cost of these services had fallen to £62,750 (including £10,955 for new wood paving). The amount expended during the four years on tar-spraying was only £6731, so it will be seen that the cost was saved many times over.

Filling of Gatun Lake—According to the plans formulated a year ago, the steel sluice gates which control the outflow of water from the Gatun Lake, Panama Canal, during the construction period were closed on Apr. 30, and will be kept closed except in the case of excessive floods until the lake level reaches an elevation of 50 ft. above sea level when the water will overflow the crest at the middle of the spillway dam. The crest of the concrete ogee of the spillway proper when completed, will be at an elevation 69 ft. above sea level, above which are to be the steel gates or flash boards, which will give the additional 16 ft. required to bring the lake to its final elevation of 85 ft. It is planned to keep the lake at a 50-ft. level for a year, during which the spillway will be completed. When the sluice gates were closed, Gatun Lake was at elevation 16.6 ft. above sea level, and it is expected that by Aug. 1 the water will have reached the 50-ft. level.

The dry excavation in the canal channel through the proposed lake is finished except for a small piece of contract work near Juan Grande. The two suction dredges now at work in the lake near the Gatun Dam will be moved to Gorgona and Gamboa to remove gravel deposits left in the channel by floods. A dike across the channel at Gamboa will prevent the flooding of Culebra Cut.

To prevent flooding the lock chambers at Gatun the upper guard gates will soon be completed and closed. Both leaves of the east chamber have already been hung and upon completion of the riveting and adjustment of operating machinery, which is now installed, will be ready for use. In the west chamber a considerable amount of riveting remains to be done, but an increased equipment and force will be concentrated on these two leaves until they are completed.

The culverts in the center and side walls, through which the water from the lake is to be passed in the operation of the locks, are being closed at the upper ends with steel bulkheads. In the operation of the locks the intakes will be controlled by Stoney gate valves, but, as it is not desirable to use them for estoppel through the long period until the canal is ready for use, the bulkheads will be used instead to afford protection from flooding. Each bulkhead consists of a series of 10-in., 30-lb. I-beams 14 ft. long, laid flat, transversely across the culvert.—"Canal Record."

1912 Flood on the Lower Mississippi

By A. L. Dabney*

Mr. Dabney, who has had long experience as an engineer on Mississippi River flood protection and control, gives here the best figures now available on the extent of the recent floods on that river and of the damage done to the various levees and levee districts. He also comments upon the stability of the levee system, the general methods of levee repair and the proper flood height for which future protection should be made.

*Consulting Engineer, 81 Porter Building, Memphis, Tenn.

By the Lower Mississippi is meant that part of the Mississippi River between Cairo and the Gulf of Mexico. Through this entire section, the flood of 1912 exceeded all former records as to the stages reached and probably also as to the total volume which passed while the river was above a bankful stage. The two former floods which stand out most prominently, as to the total volumes discharged, are those of 1882 and 1897. T. G. Dabney, Chief Engineer Upper Yazoo Levee District, has made the following comparison of these with the present flood, the values given being the sum of the products of the number of days the gages showed above 45 and 50 ft., respectively, at Cairo, by the respective excesses over those stages.

EXCESS-FOOT-DAY TOTALS OF THREE FLOODS

Year	Above 45 ft.	Above 50 ft.
1882	158	10
1897	202	17
1912	234	62

When measured by this standard, as will be noted, the same total volume passed Cairo, above the 45 stage, in 1912 than in 1897, and nearly four times as great a volume passed while the stage exceeded 50, in 1912 as in 1897.

There is presented herewith, as Table I, a table of high water stages by years at a number of stations along the Mississippi and its tributaries. This has been copied from the last report of the Board of State Engineers of Louisiana. This together with the hydrographs (Fig. 2) which were copied from the records of the Upper Yazoo District, afford an interesting comparison of the past floods with the most recent one of 1912.

The flood of 1912 was unusual in that the river was at a moderate stage up to a time which was late in the usual high-water season. The records show that all of the six preceding floods from and including 1882, which went above 50 at Cairo, have occurred in January, February or March, and those occurring in the last named month have followed comparatively high stages in February or early March. In 1882 the river was high at Cairo in January, and reached its maximum there on February 26; in 1897 the rise began in February and culminated at Cairo on March 25.

The Cairo gage is used in these comparisons, as being the key to the situation on the lower river.

Another and more remarkable feature of this flood is that while the record stages were exceeded from 1 to 5 ft. (and would have been exceeded more but for levee breaks) from Cairo to New Orleans, on none of the principal tributaries above was there experienced anything approximating a record stage. Thus the 1912 stage fell below the highest formerly recorded since 1871 by:

17.9 ft. at Cincinnati,
11.0 ft. at Nashville,
22.7 ft. at Chattanooga,
7.3 ft. at St. Louis.

But these maxima were exceptional and freakish and occurred in isolated instances.

As pointed out by Prof. H. C. Frankenfield of the U. S. Weather Bureau in his able article in ENGINEERING NEWS, Apr. 18, 1912, and by S. C. Emery, in charge of the U. S. Weather Bureau office at Memphis, this flood was the result of a series of unusual storms passing across the Lower Missouri and Mississippi watersheds and practically the whole of the Ohio watershed. These storms, as shown, were most unusual at the dates of their occurrence, in their locality of origin, and in the common course pursued by all of them.

It has been shown that none of the principal tributaries above Cairo reached record stages during this flood. The very high stages at and below Cairo resulted, therefore, from flood waves of great duration coming from all these tributaries at the same time.

The city which was most imperiled by this flood is Cairo. It is doubtful whether the city levees could have withstood the additional 2 ft. on the gage, which would have come if the levees on the west side of the river had not broken. The entire city is under levee protection and would

TABLE I. RECORD OF HIGHEST WATER ON MISSISSIPPI RIVER AND TRIBUTARIES FOR FLOOD YEARS, 1882—1912

Stream	Name of gage station	1882 Gage	1882 Date	1883 Gage	1883 Date	1884 Gage	1884 Date	1892 Gage	1892 Date	1897 Gage	1897 Date	1898 Gage	1898 Date	1903 Gage	1903 Date	1907 Gage	1907 Date	1908 Gage	1908 Date	1912 Gage	1912 Date	Highest since 1871 Gage	Highest since 1871 Date
Missouri	Omaha	14.50	6-28	14.20	6-28 5-25	15.90	4-6	15.30	7-3	17.10	4-6	14.70	7-3	14.40	6-1	17.30	7-18	19.10	7-3	...	...	23.60	1881
Upper Mississippi	Kansas City	19.20	7-3	23.80	6-26 12-29	17.20	7-5	24.90	5-21	27.80	4-17	21.50	6-12	**35.00**	6-1	23.50	7-20	30.20	6-15	23.10	4-2	35.00	1903
	St. Louis	32.15	7-4	34.80	1-12	28.10	4-9	36.00	5-19	30.95	5-2	27.20	5-23	**38.00**	6-10	28.00	7-25	34.94	6-20	30.70	4-6	38.00	1903
Ohio	Pittsburg	21.00	2-27	...	...	31.80	2-6	22.80	1-15	28.90	2-24	28.50	3-24	28.80	3-1	**35.00**	3-15	26.70	3-20	28.10	3-22	35.00	1907
	Cincinnati	58.58	2-21	66.35	2-15	**71.06**	2-14	43.90	4-25	61.10	2-26	61.40	3-24	53.30	3-5	65.10	1-21	55.70	3-11	53.20	3-27	71.06	1884
	Louisville	37.40	2-22	43.80	2-16	**46.60**	2-16	21.80	4-23	35.30	2-28	36.20	3-30	28.50	3-9	44.20	1-22	31.10	4-6	28.70	3-28	46.60	1884
Cumberland	Nashville	**55.30**	1-22	41.60	2-14	48.30	3-15	38.80	4-26	49.25	3-20	38.80	1-23	40.40	3-9	28.20	1-24	29.50	2-16	46.50	4-8	55.30	1882
Tennessee	Chattanooga	40.17	1-19	38.17	1-23	42.83	3-10	37.90	1-17	37.90	3-15	24.60	9-5	31.80	4-11	19.60	1-2	24.70	2-17	30.20	4-5	54.00	1875
Mississippi	Cairo	51.87	2-26	52.20	2-27	51.79	2-22	48.29	4-28	51.67	3-25	49.78	4-6	50.60	3-15	50.30	1-27	45.55	3-19	**54.00**	4-6	54.00	1912
	Memphis	35.15	3-9	34.75	3-6	34.15	3-13	34.50	5-2	37.66	3-20	37.39	4-10	40.10	3-20	40.30	2-3	35.55	3-24	**44.90**	4-6	44.90	1912
	Helena	47.20	3-9	46.90	3-8	47.00	5-6	45.73	5-11	51.75	4-4	49.11	4-17	51.00	3-26	50.40	2-5	45.20	3-26	**54.20**	4-20	54.20	1912
Arkansas	Mth. White River	48.40	2-28	48.00	3-9	47.90	3-7	49.27	6-1	52.42	3-29	51.05	4-19	53.70	3-28	51.90	2-7	49.50	6-1	...	...	...	...
	Fort Smith	21.80	2-23	22.80	6-11	27.90	2-14	30.90	5-19	17.00	3-20	**35.00**	5-7	24.10	5-26	18.80	1-24	32.70	5-27	21.50	4-2	35.00	1898
	Little Rock	25.70	2-25	25.80	2-19	30.60	2-15	**31.20**	5-21	23.20	3-21	29.30	5-11	26.20	6-2	20.40	1-25	27.80	5-30	24.00	5-4	31.20	1892
	Arkansas City	47.10	2-28	46.35	3-11	46.50	3-7	50.00	6-1	51.90	3-20	51.13	4-19	52.90	3-27	52.10	2-8	49.90	6-2	**55.40**	4-12	55.40	1912
Mississippi	Greenville	41.68	2-27	40.40	3-9	41.10	3-7	44.28	6-1	46.75	3-29	46.16	4-21	49.10	3-27	47.30	2-9	44.75	6-3	**50.50**	4-12	50.50	1912
	Lake Providence	38.32	3-20	36.47	3-11	38.40	3-23	41.90	6-2	44.54	3-30	44.35	4-23	46.48	3-27	46.30	2-10	44.10	6-5	**48.25**	4-12	48.25	1912
	Vicksburg	48.75	3-20	43.80	4-7	49.00	3-25	48.45	6-2	**52.48**	4-16	49.40	4-24	51.80	3-28	49.60	2-10	47.80	6-5	51.90	4-13	52.48	1897
	Natchez	47.75	3-28	44.00	4-7	47.40	3-24	48.10	6-26	49.82	5-2	47.40	4-26	50.35	3-28	48.90	2-13	48.70	6-14	**51.40**	4-16	51.40	1912
	Fulton	...	...	...	...	...	...	34.85	5-23	28.60	3-23	27.90	5-11	31.15	3-14	31.40	6-4	33.95	6-2	30.90	4-6	35.75	1876
Red	Shreveport	31.40	2-21	25.30	3-11	32.70	5-14	**35.70**	5-28	24.10	4-11	15.00	5-21	33.10	3-22	26.90	6-13	35.10	6-15	19.30	4-15	35.70	1892
	Alexandria	34.85	3-17	25.45	3-27	35.25	5-30 6-1	38.25	6-12	26.25	4-14	17.40	1-25	35.05	3-28	32.60	6-18	**41.82**	6-6	33.50	4-19	41.82	1908
Atchafalaya	Barbres Ldg.	49.90	3-27	46.30	4-8	48.60	3-30	49.70	6-27	50.95	5-13	42.35	5-2	50.50	4-7	45.70	2-19	48.00	6-14	**53.35**	5-10	53.35	1912
	Melville	37.00	...	...	...	...	...	35.00	7-2	35.10	5-15	33.90	4-29 5-4	38.70	4-4	37.70	2-20	39.70	6-22	**41.90**	5-6	41.90	1912
Mississippi	Red River Ldg.	48.50	3-27	45.20	4-9	47.30	3-29	48.87	6-27	50.20	5-14	44.30	4-28	50.08	4-8	46.90	2-15	48.74	6-14	**53.20**	5-11	53.20	1912
	Baton Rouge	35.95	3-26	35.08	4-9	36.20	3-24	38.45	6-28	40.65	5-13	34.60	4-29	40.05	4-7	37.40	2-17	39.60	6-16	**43.80**	5-11	43.80	1912
	Plaquemine	31.30	3-21	30.80	4-9	31.70	3-24	33.50	6-13	36-25	5-13	30.57	4-29	36.12	4-5	33.40	2-17	35.20	6-15	**39.74**	5-11	39.74	1912
	Donaldsonville	...	...	...	...	35.70	6-1	30.15	6-13	32.75	5-13	27.95	4-28	32.23	4-7	30.00	2-15	31.60	6-18	**34.80**	5-11	34.80	1912
	College Point	23.20	3-26	23.45	4-9	24.10	3-24	25.62	6-13	27-95	5-15	23.50	4-27	27.81	4-5	25.90	2-15	27.19	6-17	**30.18**	5-11	30.18	1912
	Carrollton	14.95	3-27	15.40	4-7	15.60	3-18	17.35	6-10	19.17	5-13	15.90	4-25	19.42	4-5	18.70	2-16	18.75	6-18	**20.70**	5-11	20.70	1912
	New Orleans	15.80	3-27	...	...	16.20	3-26	17.60	6-11	19.50	5-13	16.90	4-27	20.30	3-30 4-1	19.80	2-13	20.00	6-19	**21.40**	5-9	21.40	1912
	Fort Jackson	...	...	...	...	...	...	6.90	3-31	7.20	4-22 11-14	6.70	4-23	8.05	3-27	8.30	2-14	8.10	2-14	**8.50**	5-3	8.50	1912

Compiled from publications of the Mississippi River Commission ("Stages of the Mississippi River") and of the U. S. Weather Bureau; Office Board State Engineers, New Orleans, May, 1912.
Heavy type figures indicate highest water of record.
Date given is for month and day, thus 3-2 is March 2.

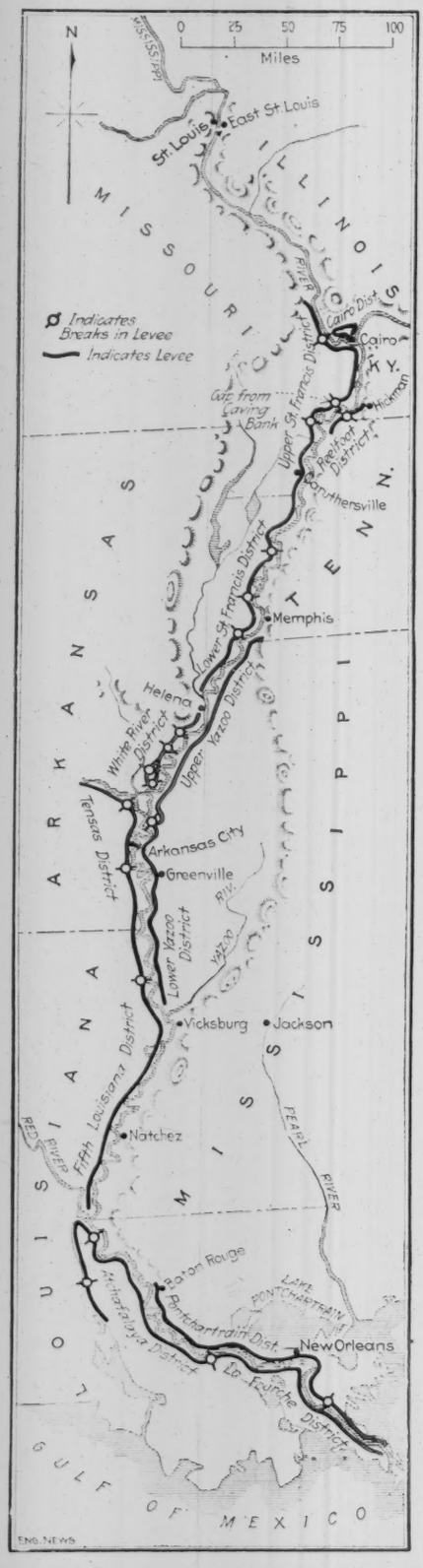


FIG. 1. MAP OF THE LOWER MISSISSIPPI RIVER, SHOWING EXTENT OF PRESENT LEVEE SYSTEM AND BREAKS IN LEVEES IN 1912

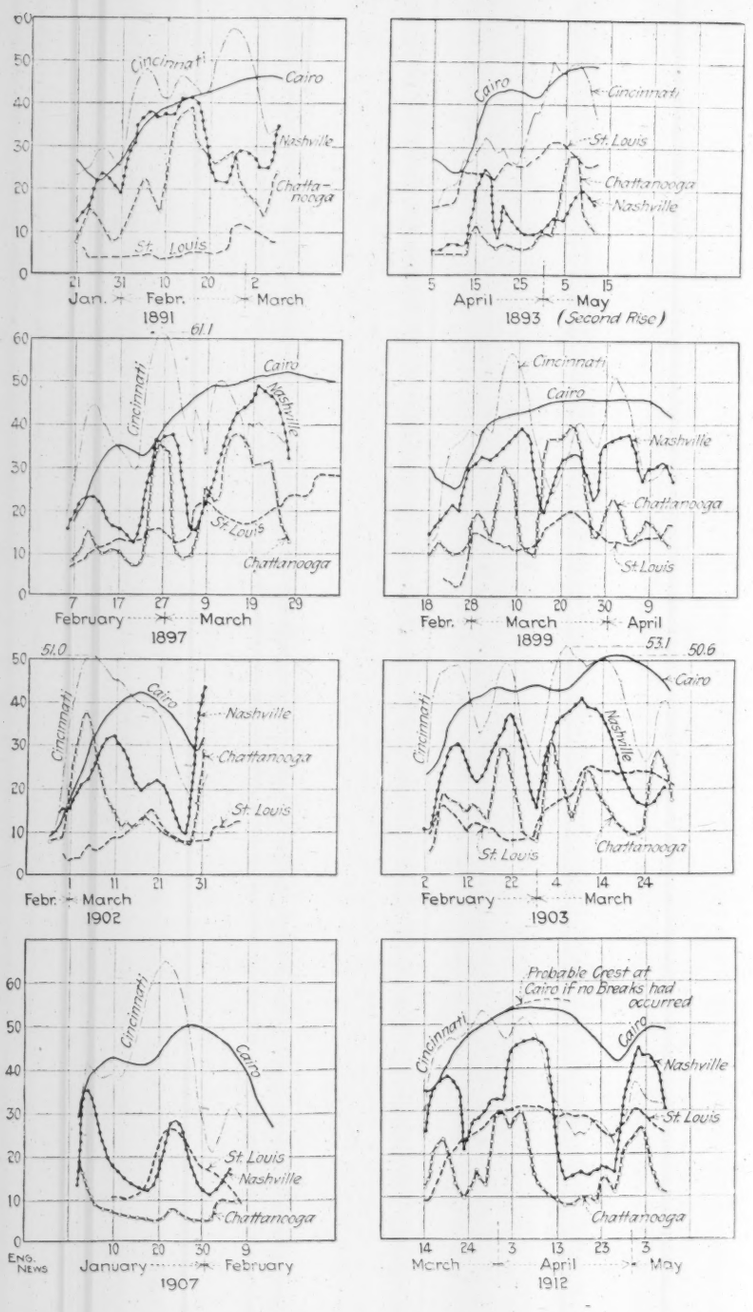


FIG. 2. HYDROGRAPHS OF LOWER MISSISSIPPI DURING FLOOD YEARS 1891 TO 1912

have been submerged by a break. New Orleans, also, is entirely below flood level, but only had to withstand 1.1 ft. more than the former record, while there occurred at Cairo 1.8 ft. more, and at Memphis 5 ft. more than the highest formerly recorded. With the much smaller range on the New Orleans gage, a large additional volume makes much less addition to the gage height than at points higher up the river. The conditions at Memphis were not as serious as pictured. Memphis is built on a bluff, the business district lying from 25 to 40 ft. above the river at the highest stage reached this year. A low area lying along Wolf River, which enters the Mississippi at the north end of the city, is occupied by saw mills and small tenements and no attempt has ever been made to protect this. In the valley of a creek that runs northward through the northwest portion of the city, about 150 acres of closely built-up territory had been protected by a levee against a 42-ft. stage. The water went 3 ft. above this levee, flooding 1¼% of the area of the city. The gas plant and the main water-works pumping station are within this area. The former had to stop running; the latter was protected by a concrete wall and continued to operate without interruption, but the water was contaminated by river water entering the suction tunnel through a broken shaft head.

TABLE II. MISSISSIPPI RIVER LEVEE DISTRICTS. APPROXIMATE DATA AS TO DIMENSIONS AND BREAKS IN 1912

NAME OF DISTRICT	Side of River	State	Date of Organization	Date of first work by Miss. River Commission	Miles of Levee Front	Average height as built	Average deficiency below standard Grade	Greatest deficiency below standard Grade	Standard grade for top of Levee equivalent to stage on: Cairo Gage	Memphis Gage	Helena Gage	Arkansas City Gage	Greenville Gage	Vicksburg Gage	Natchez Gage	New Orleans Gage	THE SECTIONS BELOW SHOW: Standard proposed before 1912 H.W. — Average for district as built ..... Minimum in district as built ———	Number of Breaks in 1912	Total Length of Breaks	Area of District in sq. Miles	Percentage of District Flooded
Upper St Francis	W.	Mo.		1898	55	12 ft	2 ft	4.5 ft.	55.2									2	25 Miles	700	Practically all
Cairo Drainage District	E.	Ill.	1888		15	15 ft.		1.2 ft	56.0								Varies	7	800 ft.	11	All
Reelfoot	E.	Ky & Tenn.			21	11 ft	2 ft	3 ft	55.2	45.0								1	5,500 ft	310	All
Lower St Francis	W.	Mo. & Ark.	1893		215	16 ft	40% of Yardage	Approx 3 ft.	55.2	45.6	56.2							3	(4000 in open Gap) 10500 ft.	3125	80%
Upper Yazoo	E.	Miss	1884		98.5	18.5 ft.	0	1.5 ft.	57.0	47.0	57.6							0	0	3680	0
White River	W.	Ark		1887	75	12 ft	2 ft	4.0 ft			56.2							5	5400 ft	910	80%
Lower Yazoo	E.	Miss.	1865		187		1.5 ft	3.5 ft			55.0	56.9	53.1	55.8				1	2400 ft.	2600	50%
Louisiana Districts	Both	La. & Ark	1886 to 1898		1140													10		Estim 14000	20%

▨ A few hundred yards were 1 or 1½ ft below standard, but still had ample margin ▨ Including area not protected by Levees; about 30% of all alluvial lands in State were Overflowed

TABLE III. APPROXIMATE DATA ON BREAKS IN LEVEES IN 1912 FLOOD.

NAME OF DISTRICT	Side of River	State	Name of Break	Location	Date of Occurrence	Width at Date of this Information	Sections of Levee at Breaks showing water level at time Break occurred (Drawn to Scale) All Levees have 8 ft crown and 1:3 Slopes	Deficiency below Standard Grade, ft.	Water Level when Break occurred (Feet above or below Top)	CAUSE OR MANNER OF OCCURRING
Upper St Francis	W.	Mo.		From opposite Cairo northward for 20 Miles	March 30th to April 6th	Aggregate 22,000 ft.	Sack Topping 4' to 10'	4.5'	About 1.5 ft. above when Breaks began	Mainly occurred in small and inadequate Levees that had been built by the County Districts and had never been worked on by the Miss. River Com. over a length of 25 mi. (in two places) There were abt 80 Gaps washed
Upper St Francis	W.	Mo.		About opposite Hickman Ky.	March 30th to April 6th	Aggregate 22,000 ft.	Sack Topping 4' to 10'	4.5'	do.	
Cairo Drainage District	E.	Ill.	Seven Small Breaks	Just above Cairo	April 3rd and 4th	Aggregate 850 ft.		2'	0	Seven Breaks occurred: Most of them by sloughing of landside slope which was steep. One by deep landside borrow pit
Reelfoot	E.	Ky.	Hickman	5 Miles below Hickman	April 5th	5500 ft	11'	3'	1 ft. Above	Windstorm Waves undermined Sack Topping
Lower St. Francis	W.	Mo.	Pt. Pleasant	Just below Pt Pleasant		4000 ft.				Levee had caved into River two Years ago and River Commission prepared to close Gap. Local Authorities had not succeeded in acquiring necessary right of way. Gap left open
Lower St. Francis	W.	Ark.	Wilson	40 Miles above Memphis	April 10th	4000 ft	1:2 15'	3'	1 ft. Above	Blow-out from Sandboil at toe of Slope
Lower St Francis	W	Ark.	St. Clair	10 Miles above Memphis	April 6th	2500 ft	18'	1'	1 ft. Below	Blowout
Lower St Francis	W.	Ark.	Wynoak	10 Miles below Memphis	April 6th	4000 ft	13'	2'	Just Above	Overtopping
Upper Yazoo	E.	Miss.	None							
White River	W.	Ark.	Modoc	23 Miles below Helena	April 6th	3200 ft	18'	4'	0.5 ft. Above	Leak appeared in back Slope and suddenly blew out
White River	W	Ark.	Ferguson	57 Miles below Helena	April 15th	1200 ft	17'	1'	1 ft. Above	Overtopping
White River	W.	Ark	Laconia Circle Back Levee	One Mile below Laconia	April 7th	700 ft.		2'	2 ft Below	Blowout
White River	W.	Ark.	Laconia Circle Front Levee	One Mile below Henrico		300 ft.	Backwater			After circle filled from Break in back Levee, this Break was caused by Water running over top to get back into River
Lower Yazoo	E.	Miss.	Beulah	4.2 Miles above Greenville	9 P.M. April 17th	2400 ft	23'	2'	0	Sand foundation. Sandboil near base. "Hoop" of sacks being built when banquet caved in and blowout occurred
Upper Tensas (La.)	W.	Ark	Lake Jefferson	Near Mouth of Arkansas River	April 16th	960 ft		4'	2.5 ft Above	Overtopping
Upper Tensas (La)	W.	Ark	Panther Forest	16 Miles below Arkansas City	April 12th	2350 ft		3'	0	Sloughing of landside embankment
Fifth Louisiana	W.	La	Alsatia	17 Miles below Lake Providence	April 12th	5000 ft		2'	3 ft Below	Sandboils
Louisiana (Not shown on Map)	W.	La	Torras	Mouth of Red River	May 1st	3000 ft	10'	0.5'	3 ft. Below	Sloughing landside enlargement
		La	Hymelia		May 14th	2500 ft	12'		3 ft. Below	Unstable Substrata
	E.	La.	Nestor	60 Miles below New Orleans	May 14th	Closed soon after	8'		2.5 ft Below	Crawfish Holes
	S Bank Red River	La	Normands	45 Miles below Alexandria		200 ft	9'		Top (?)	Cut for Roadway improperly filled
	S Bank Red River	La.	Lakelong	53 Miles below Alexandria		250 ft.	35'		3 ft. Below	Cut (?)
	W Bank Atchafalaya R.	La.		12 Miles below Head of River	May 19th	1500 ft.	10'		2.5 ft Below	Sandboils
	W Side Atchafalaya R	La	Alkins Bayou	25 Miles below Head	April 10th	5300 ft	12'		4 ft. Below	Cut (?)
	E Side Atchafalaya R.	La.	McCracken Bayou	30 Miles below Head	April 6th	5300 ft.	12'		0	Overtopping

Heights

Eng. News

Effect of Flood on Lower Levee Districts

Fig. 1 is a map of the Lower Mississippi, showing extent of the levee system and the location of the crevasses in the 1912 flood. From information furnished by the chief engineers of the larger districts and by U. S. engineers at Memphis and Vicksburg, the accompanying tables have been prepared. The figures given in these tables are necessarily rough approximations. Table II shows that from Cape Girardeau, on the west side, and Cairo, on the east side, to the Gulf, a total of about 2000 miles of levees, built to protect some 25,000 sq.miles of land, had 22* breaks (counting those in the Upper St. Francis as two in number) aggregating in length about 20 miles and flooding an area roughly estimated to be 32% of that which they were built to protect. Only three crevasses occurred on the east side of the river between Cairo and New Orleans. Two of these were in small local basins; one, the Reelfoot in Tennessee, and the other, near Bayou Sarah, La., being unimportant and not listed in the table; the third occurred in the Lower Yazoo District in Mississippi, flooding about 50% of the area in that district, or 21% of the total area under levee protection in Mississippi. There were no breaks on the east side of the river between Baton Rouge and New Orleans.

A careful study of these tables will show that nearly all breaks occurred from "sand-boils" or "blow-outs" and a few from "sloughing" of the landside slope; all being in levees of recognized deficiency of height and section, measured by the standards set by former record stages. The standard levee is supposed to have its crown at least 3 ft. above the highest known water. It will be noted that usually where breaks occurred the water stood in some cases a foot or less below and in some cases considerably above the top of the levee (being held by a temporary topping of earth-filled sacks, as shown in Figs. 3-4). In several cases the breaks were caused by water running over the levee, because of the inadequacy of the force to build the topping as rapidly as the water rose.

*Twenty-nine breaks shown in Table II include small breaks on minor rivers.

TABLE IV. STAGES OF HIGH WATER AND PROVISIONAL GRADES (JULY 1898) ADVANCED BY THE MISSISSIPPI RIVER COMMISSION

From Office of Louisiana State Board of Engineers.

Name of gage station	Elevation of "O" at gage Cairo Datum	Highest water of record previous to 1912		Estimated ultimate high water M.R.C.	High water 1912	Provisional grade M.R.C.
Cairo	290.84	52.20	1883	54.17	54.00	56.17
Memphis	203.97	40.30	1907	41.60	44.90	43.60
Helena	161.98	51.75	1897	54.10	54.30	56.10
Mouth White River	128.73	53.70	1903	56.40	56.30	58.40
Arkansas City	116.44	52.90	1903	56.30	55.40	58.30
Greenville	108.00	49.10	1903	50.50	50.50	54.80*
Lake Providence	89.62	46.48	1903	48.00	48.25	51.00*
Vicksburg	66.04	52.48	1897	55.05	51.90	57.00
St. Joseph	52.74	48.07	1903	50.80	48.60	52.80
Natchez	36.89	50.35	1903	54.00	51.40	56.00
Red River Ldg	29.85	50.20	1897	52.50	53.20	54.50
Bayou Sarah	23.95	43.70	1897	45.70	47.20	47.70
Baton Rouge	20.06	40.65	1897	43.20	43.80	45.20
Plaquemine	21.06	36.25	1897	38.70	39.74	40.70
Donaldsonville	19.48	32.75	1897	34.95	34.80	36.95
College Point	21.24	27.95	1897	29.80	30.18	31.80
Carrollton	20.91	19.42	1893	20.35	20.70	23.35*
Fort Jackson	19.26	8.30	1897	8.00	8.50	10.50*

*Grades increase since July 1898.

Osceola, Ark.

Luxora, Ark.

Figs. 3-4. River in Flood at Points in Arkansas
(Note height above neighboring land.)

Closing the Crevasses

It is unusual to attempt to close a crevasse while the water is flowing through it. After the water recedes, a new levee is built round it in the regular way. Frequently the length of this levee is two or three times the length of the crevasse. The violent rush of water through the gap washes a hole (sometimes 50 ft. deep below the ground surface) extending the length of the crevasse and for some distance transversely. The new levee is located far enough back from this to leave room between for riverside borrow pits.

There are a very few instances of the closure of crevasses while the water flowed through, but even where it is possible to accomplish this, the expenditure is not justified except in very special cases. If the river should continue above its banks during the time necessary for the closure to be effected, it would, in most cases, recede soon afterward. There have been more such closures effected in southern Louisiana than elsewhere, because there the crevasses are usually not so wide, the levees not so high, the foundation material much less subject to erosion and the levees located near the river banks so that steamboats, barges, floating pile drivers and other equipment can be readily assembled to do the work.

In 1897 a crevasse of 2070 ft. width was closed in the Upper Yazoo Levee District. In 1903 the Lower Yazoo District closed a crevasse just below Greenville, Miss. In the latter case steamboats and steam pile drivers were used.

The difficult task to be accomplished is the imposing of a solid obstruction to the flow of water at a high velocity (probably at least 6 ft. per second at the time of closure) over a bottom that erodes readily. In addition to this, there is the further difficulty of procuring the necessary material for the structure. There is no rock available. Sacks of earth must be substituted. There is no land for miles in any direction. The only available earth is the top of the remaining portion of the levee, which may stand 5 or 6 ft. above the water after the latter has fallen somewhat from its maximum

stage. The plan now adopted for the closure of a crevasse is to drive an open-pile structure entirely around it; then revet the ground to prevent underscour. The velocity may then be reduced by filling the pile dike with brush, and a bank of sacks be built on the upstream side.

It is believed that the plan of building the open-pile dike entirely around before doing anything else was first used by the writer in the Upper Yazoo District in 1897. The dike was 2600 ft. long. When the closure was completed, the depth of water along the dike ranged from 3 or 4 ft. to 13 ft. for a limited distance. Brush was not used. After the pile dike was built, a double walkway was laid on top, then the bottom within and behind was revetted with sacks. Next, additional piles were driven along one side, until they covered the entire length on about 12-in. centers. Sacks were then filled into the dike, in the deepest water first, and the crest of the filling kept always horizontal, so that the depth of flow over the crest was the same at all points. Finally the entire crest was brought to the water surface and the flow cut off.

This crevasse was at a locality inaccessible to boats and steam equipment. All piling (4x4 in. square and small round poles) was driven by hand with heavy wooden mauls. It was transported on small flatboats propelled by hand. Sacks and sawed piling were hauled several miles by wagon over almost impassable roads and then on flatboats. After filling the sacks from the levee ends, they were wheeled on barrows onto the dike (maximum distance wheeled about 1600 ft.).

FIG. 5. TOPPING A REVETMENT. WELL OVER SAND BOIL IN LEFT FOREGROUND

The justification for the cost of this closure was that it was late in the planting season and a secondary rise had appeared in the upper rivers which would prolong for several weeks the flow through the crevasse.

The question will present itself to those not familiar with the local situation, "Why were the levees not built to the standards that had been adopted for them?" The history of the Upper Yazoo District will answer this question. It is analogous to that of the other districts except that its levee is now the farthest advanced. This district was organized in 1884, and its territory was nearly all an unproductive wilderness. An issue of $500,000 of 8% bonds was authorized. These bonds, after much effort, were finally sold at 12½% below par. The 1882 flood had all but obliterated the haphazard and inadequate levees which had been built by individual and neighborhood effort, and the proceeds of this bond issue were used to close the gaps in and build a scant enlargement upon this old line of levees. Partial protection gave a measure of confidence, so that from time to time other bonds were authorized and sold at lower rates of interest, and other enlargements put on; but the entire line was never brought to the then tentative standard grade and section before a new grade had to be adopted, to meet a further elevation, locally, of the flood plane, due to closing gaps and lessening the escape of water into the St. Francis and White River Basins opposite; until finally, about two years ago, after 26 years of enlarging, prolonged by the absence of definite data as to the ultimate effect on the flood stage of closing all gaps on the other side, and prolonged further by the caution of the people of the district in the matter of going into debt too rapidly, this district was finally brought to its adopted grade and section. This grade, considered final until two months ago, provided for 3 ft. margin above a stage of 44 ft. at Memphis. The district was further handicapped by a constant draft on its finances to rebuild long sections of the levee further from rapidly caving banks.

The weakest of the districts were organized more recently than the one just discussed. They have generally more levee front per acre and a larger percentage of wild land. They are still enlarging their levees, as their finances will permit. Their engineers and those whose lands are dependent upon them knew that they were not finished. The last annual report of the chief engineer of the Lower St. Francis District (made before the 1912 flood) stated that the levees in that district were only 60% completed.

FIG. 6. REVETMENT OF THREATENED SLOUGHS AND WELLS OVER SAND BOILS

The defect in the levees as they now stand is insufficiency of earth. The editorial in ENGINEERING NEWS of May 23, 1912, very well shows that concrete core walls or similar devices are not what is needed. The levees are all founded upon earth. Frequently or usually, there are permeable strata beneath, reaching too great depths to be penetrated by impermeable structures within anything like the cost for which the levees can be made secure by other means. The pressing defect with most of the levees is scant height and section; but when this is cured, attention must be given to the weak foundation upon which many levees rest. It is believed that no levee has ever broken where the section closely approximated the standard generally adopted and where the top stood 3 ft. or more above the water surface, except through permeability of the underlying material.

Recognizing this condition a number of

years ago, the chief engineer of the Upper Yazoo Levee District adopted two methods of meeting: first, by adopting 1 to 4 landside slope and a banquette 40 ft. wide, in contrast to the Mississippi River Commission standard of 1 to 3 and 20 ft. banquette, thus widening the base and lengthening the travel of seep water under the levee; second, in the more aggravated cases of leaky foundations, building sub-levees of considerable extent, to pond water from 3 to 10 or more feet deep over wide areas behind the main levee, succeeding, by this method, in almost completely suppressing the sandboils within the area thus flooded. There has never been any trouble from displacement of material by the passage of seep water, on portions of the line supported by this counterhead.

FIG. 7. PROTECTION WORK ON LAND SIDE OF LEVEE

(Showing, in addition to brush and sack and plank and sack revetment, the "wells" built around "sand boils" or large seeps partly to suppress the flow by a counter head.)

The remedy for weak foundations is to extend the above two principles as far as necessary for reducing the velocity of seep water to such a degree as to insure that it will take no material with it from under or near the levee.

FUTURE LEVEE WORK

Have the levees of the Lower Mississippi been a failure? It has been shown that all of the levees which broke this year were below the standard grade and section. Had all levees been 5 ft. higher, with sections equal to the standard of the Upper Yazoo Levee District, the 1912 flood could have been safely passed between them from Cairo to the Gulf of Mexico. The Upper Yazoo District, covering the first 100 miles of river front from the upper end of the Yazoo Delta in Mississippi and protecting two and one-third million acres, had no break and had sufficient margin and section to have withstood about 3 ft. more water, this being the limit of what would have passed that direct if no breaks had occurred in any levees. No serious weakness appeared at any point in this district. There was hardly a wet spot from seep water, on the levee slope, above the banquette, along the entire line. Occasional sandboils were readily controlled by rings of earth-filled sacks.

What future flood stages on the Lower Mississippi should be provided against? The remarkable development within the several levee districts during the last few years has been such that the damage wrought by a break in the levee exceeds many fold what would have resulted 20 or even 10 years ago. This development has been proceeding at an accelerating rate, and will so continue. Accordingly, communities dependent upon levees for protection cannot, in future, take the chances of having breaks that they have heretofore taken.

Reasoning by probabilities, we have seen about 30 years pass before there was a recurrence of the 1882 and 1883 stages at Cairo (51.8 and 52.2, respectively); 1844 is spoken of as the great flood prior to 1882. Even if this flood is assumed to have been as high at Cairo as the 1912 flood, a period of 68 years has intervened before a recurrence. It is probable that another 68 years will pass before we have a repetition of the 1912 stage at Cairo.

In considering the stage this year at Cairo, however, it should be taken at what it would have been had no breaks occurred. Prof. Frankenfield and T. G. Dabney have independently arrived at the same conclusion—that Cairo would have reached 56 ft.; the process used by the latter being to produce the hydrograph curve from the point that had been reached when the levees in that vicinity gave way, as a curve analogous in shape to that assumed by the Cairo hydrograph during floods which produced no breaks in that vicinity. (See Fig. 2.)

The relations between the Cairo, Memphis and Helena gages are fairly well known and it can be stated that with 56.0 at Cairo and no breaks, the stages at Memphis and Helena will be within a few tenths, one way or the other, of 47.5 and 56.5, respectively.

It is possible, as intimated by Prof. Frankenfield, to have a combination of conditions which will result in even higher stages on the Lower Mississippi than would have been recorded this year in the absence of breaks; but protection against every possibility of disaster cannot be expected more in this than in other structures. It is the writer's belief that 56.0 at Cairo, 47.5 at Memphis and 56.5 at Helena should be adopted as the probable maxima, the stages at points below to be projected from these; that the levees should be built to grades 4 ft. above these stages with ample section to cover the necessary width of foundation; and that the sub-levee plan should be greatly extended, using greater depths of counterhead where large volumes of seepage so indicate, with possibly a resort to very deep sheet piling in a few particularly aggravated cases of bad

FIG. 8. VIEW OF LANDSIDE OF WEAKENED LEVEE

(Note seep water in borrow pit. Back side of sack topping is shown; also method of revetting soft slopes to prevent sliding. Usually saplings and brush are used under the sacks. When these are not available, plank may be used as shown here. The branches or plank must lie up and down the slope, so as to permit the water to flow away under the sacks.)

foundation, of limited extent. With these things accomplished and with the caving river banks revetted, the Valley of the Lower Mississippi can rest in full assurance of flood protection for all time, as much as would be justified by a reliance in the integrity of most of the works of man.

Space does not permit a discussion here of the points of analogy and difference in the hydrographs in Fig. 2, but particular attention is called to the effect of St. Louis on Cairo, as illustrated by them. Table IV gives the stages of high water and the provisional grades for levees advanced in 1898 by the Mississippi River Commission.

Acknowledgment is here made for the data upon which this paper is based, to the engineers of the several districts and of the Mississippi River Commission, the City Engineer of Cairo and the officials of the U. S. Weather Bureau.

Annual Convention of the American Water Works Association

The thirty-second annual convention of the American Water Works Association was held at Louisville, Ky., June 3 to 8. The attendance was satisfactory, the program interesting, the exhibits attracted much attention, and entertainment and social features were well up to standard. A large number of papers and committee reports were presented and discussed. In addition, there was some formal discussion, either brought out by the question box or else quite voluntary.

PRESIDENT'S ADDRESS—Alexander Milne, superintendent of water-works, St. Catharines, Ont., was unable to be present, owing to important construction work which he felt that he could not leave. His address included recommendations for increasing the membership of the association and for keeping down its expenses until it is in better financial shape. Mr. Milne also apologized for the delay in the publication of the 1911 *Proceedings* (just published) and for some disorganization in the other work of the secretary, both due, he stated, to the moving of the secretary from Charleston, S. C., to Troy, N. Y., as well as to illness.

REPORT OF SECRETARY-TREASURER—John M. Diven, Troy, N. Y., reported a total membership, including names just acted upon by the executive committee, of 955, all in good standing. The finances of the association, he stated, were covered by the report of the finance committee.

PAPERS AND DISCUSSIONS

More than a score of formal papers were entered on the program, besides the numerous committee reports and a Question Box.

ANCIENT AND MODERN WATER-WORKS—An interesting lantern-slide talk, devoted chiefly to the aqueducts of Rome, other parts of Europe and New York City, was given by Edward Wegmann, of the Department of Water Supply, New York City. The nine aqueducts described in the noted book by Frontinus as having been built between 312 B. C. and 52 A. D. had a total length of 262.6 miles, of which 39.5 were on arcades and the remainder, or 223.1 miles, were in tunnel. The four aqueducts of modern Rome, built from 1570 to 1870, have a combined capacity of some 100,000,000 gal., or a trifle over the corrected figures for the grossly over-estimated total capacities of the ancient aqueducts.

FLOOR AREA MEASUREMENTS OF WATER CONSUMPTION — An apparently novel method of computing water consumption was described by Wm. W. Brush, deputy engineer of the Department of Water Supply, New York City. The unit used was the number of gallons per day per 1000 sq.ft. of total floor area of buildings. The study was made primarily as an aid to the design of the distribution system of the new Catskill supply, but will also aid in deciding on the size of taps or service connections for various classes of buildings. The paper, in condensed form, appears elsewhere in this issue.

REMINISCENCES—Led by Capt. H. G. H. Tarr, whom many will remember as an important factor in the Henry R. Worthington pump business, several members gave interesting reminiscences of water-works experiences. Capt. Tarr began work as a boy on the Brooklyn water-works in 1857. After the Civil War, in which he served on the Union side, he went into the pipe business and still later he engaged in the manufacture and sale of pumps. He has seen the duty of pumps increase from 70 to 176 million and the corresponding unit costs fall from $18,000 to $5000 per million gallons. He described some pipe-bidding pools which were formed at contract lettings in days when "graft" was known only to horticulture and "trust" meant absolute fidelity.

John Caulfield, for 43 years connected with the water-works of St. Paul, told of some plain cement pipe laid over 40 years ago that is still in good condition. Stuart Wood, of Philadelphia, told of pipe made years ago from bog iron from small furnaces in New Jersey. He also told of visiting St. Louis secretly many years ago at the instance of the City Engineer and breaking into a nicely planned pipe-bidding pool with a low bid on the stroke of 12.

ORGANIZATION OF THE BUREAU OF WATER SUPPLY, NEW YORK CITY—I. M. de Varona, Chief Engineer of Water Supply, New York City, was scheduled for a paper on this subject, but instead a paper was read by Henry B. Machen, borough water engineer for Manhattan. The New York water department has been reorganized within the past year or two. On the engineering side there is now a chief and a deputy-chief engineer, and under these there are divisions of new construction and of maintenance, with various subdivisions. There are four borough engineers. The water-waste division, first organized to cover the whole city, is now placed under the distribution division of each borough. Above the engineering force is a commissioner of water supply, with a deputy commissioner for each borough. The reorganization has cut down the total number of employees by some 220, or to about 990, and reduced salaries by some $300,000 a year.

THE PHILOSOPHY OF PURCHASING SUPPLIES—A paper on this subject, by E. C. Church, naturally followed the one just outlined, as Mr. Church is secretary of the Department of Water Supply, and acting chief of the Bureau of Supplies, New York City, and has just reorganized that bureau. An abstract of Mr. Church's paper will be given in a later issue.

EFFICIENT MANAGEMENT — The close attention given to Mr. Church's address was extended to one by Harrington Emerson. The speaker described strenuousness as much effort used to produce a slightly increased result and efficiency as slightly increased effort with greatly increased results. System is one of the worst obstacles to efficiency, because it makes against change of methods, which is often essential to efficiency. Records are an essential to efficiency and must be reliable, immediate and absolute. Efficiency means omission—of things which ought not to be done. Most people know what they ought to do, but do not know what they ought not to do. Scientific principles must be supplemented by ethical principles. If this is done, friction disappears while waste is eliminated.

STEAM TURBINES AND CENTRIFUGAL PUMPS—A detailed comparison of capital and operating costs of a 40,000,000-gal. unit turbine-driven centrifugal pump and a high-duty reciprocating pump of the same capacity was made by W. O. Beyer, of the Dravo-Doyle Co., Pittsburgh, Penn. Many data were given in the form of tables and diagrams. The comparison was favorable to the centrifugal pump, but was promptly challenged by J. N. Chester, of Pittsburgh, in a lengthy discussion. Among other objections, Mr. Chester urged that the turbo-centrifugal pump can be used only under uniform loads and is therefore unavailable for direct-pumping systems, which constitute a large percentage of all systems. Moreover, only a few cities can use large units. He thought the centrifugal pump had not yet reached the high stage of perfection which the author claimed, but presumed it would be greatly improved in the next five years. L. E. Strothman, of the Allis-Chalmers Co., Milwaukee, said that while he was interested in both types of pumps, he endorsed Mr. Ches-

ter's remarks and reinforced and extended his points, noting, among other things, that cities are giving up reservoir heads for direct pumping. J. S. Fuller, associated with Mr. Beyer, came to the support of the latter.

ELECTROLYSIS FROM STRAY ELECTRIC CURRENTS—An address on electrolysis of underground pipes, with lantern slides, was delivered by Prof. Albert F. Ganz, of Stevens Institute, Hoboken, N. J. The theory and practical aspects of electrolysis were fully explained, remedies set forth and some comments were made on the recent Peoria decision. The speaker minced no words in stating that electric railways should be held directly and wholly responsible for electrolysis, and that their arguments to the contrary and their pleas for being allowed to return their current to the power house through metal pipes are prompted by a desire to save power and money at the expense of pipe owners.

Draining pipe by connections to the negative busbar at the power house should be absolutely prohibited because it increases the flow through the pipe and makes the pipe owner jointly responsible with the railway company for any damages which may occur. Insulating joints are useful in special cases, but should not be used generally. Under very special circumstances the whole pipe may be insulated, say by a covering of pitch, boxed in. "Insulating paints" were condemned.

The only real preventive of electrolysis is a complete return of the current to the power house by a copper circuit. Where the railway owns the right-of-way a nearly complete return may be effected by insulating the rails from the ground.

Much can be done by draining through insulated feeders, properly proportioned. On this point Prof. Ganz said:

Experience shows that where there is serious trouble from electrolysis caused by large stray currents leaking from street railways, the bulk of this trouble is due to defective rail bending, to ground connections from the negative busbar, and to lack of return feeders to bring current back from the rails to the power station. While stray currents can only be entirely eliminated by insulating the return circuit by the use of a double trolley, either overhead or in conduit, it is nevertheless a fact which is not generally appreciated, that where large stray currents exist, there can always be reduced to a small fraction of their present value by removing all ground connections of the negative busbar, and installing insulated return feeders proporti ned for equal drop from radially-disposed points in the track system located at some distance from the power station. By this method the rails are drained of current and any desired part of the voltage can be removed from the rails and transferred to insulated conductors from which currents cannot leak.

In Europe, such radial insulated return feeders for bringing current back from the rails to the power station are made necessary by regulations limiting the allowable drop in voltage in the rails, and in most cases such installations of insulated return feeders have substantially removed serious trouble from electrolysis. This system of minimizing stray currents by means of radially disposed insulated return feeders has also been installed in a number of American cities, and the method is generally being recognized as by far the best for minimizing stray currents. This system in fact removes the root of the trouble, by draining the rails of current and removing voltage drop from the rails and thus preventing substantial leakage of current through ground, and is therefore correct in principle.

The railroad companies frequently object to this system claiming that it is prohibitively expensive. This is certainly not the case, as is evidenced by the fact that the method is in general use in Europe and in a number of American cities today. The fact is that in many electric railways there is practically no installation of negative feeders and the railway companies are often not willing to install even a moderate amount of return feeder copper.

A mistake is often made in confusing the radial insulated return feeder system with paralleling the rails with copper. Of course where the negative busbar is connected to the rails at the power station, and these rails are paralleled with copper feeders, the drop in the rails is reduced in the proportion that the conductivity of the return circuit is increased, but no part of the drop is actually removed from the grounded rails. The amount of copper paralleling the rails that would be required to reduce stray currents to a negligible amount would in all large systems be absolutely prohibitive. This, however, is not the case with the radial insulated return feeder system. With the latter system any desired reduction in rail drop and consequently in the amount of stray current can be secured, independent of the amount of copper installed, the amount of copper being determined by the allowable drop or power loss in the return circuit.

The pipe-owning companies suffer constant expense on account of stray railway currents in the form of repairs and depreciation of their underground structures, and in the form of liability for accidents, and this can be reduced with certainty to any desired extent, short of complete elimination, by the assumption on the part of the railway company of expense in the form of interest and power charges for its return circuits. The railway companies should in all fairness assume this expense and responsibility. If the railway companies would apply as much engineering knowledge and money to their negative circuits there would be but little trouble from electrolysis.

The recent Peoria electrolysis decision places the burden of preventing electrolysis squarely on the railway company, where it belongs. Commenting on the portion of the Peoria decree which authorizes the railway company to come back to the court, in case stray currents exist after trying remedies, Prof. Ganz said:

A drainage system such as contemplated as a possible final measure by the Peoria degree, when properly controlled so that only small currents are drained from the pipes, does not have the objectionable and dangerous features of promiscuous bending where large currents are made to flow on the pipes as often found in American cities, and may even be a safe final method where the soil conditions are favorable and where the underground structures are all continuous electrical conductors. It nevertheless seems to the author very unfair that any pipe-owning company should be compelled by a court order to permit an electric railway company to use its pipes as a return conductor for its railway system, even to the slightest extent. If the court does not have the power to compel the railway company to adopt any specific method for eliminating the danger from electrolysis, then it certainly should not impose any specific method upon the pipe-owning companies. The latter may for example prefer to remove any small remaining stray currents by means of properly located insulating joints.

It is the author's firm conviction that such remedial measures as pipe drainage or insulation pipe joints should be used if at all, only as a final measure and never until the return circuit of the railway has been improved so that only small amounts of stray current remain on the underground structures. This view appears to be entirely in accord with the Peoria decision, and is certainly in accord with the best engineering practice.

CHLORINATION AND TYPHOID FEVER AT CLEVELAND, OHIO—Studies of the treatment of water with hypochlorite at Cleveland, Ohio, with comments on typhoid fever and its causes in that and other cities, were the subject of a lantern-slide talk by D. D. Jackson, of New York City. When chlorination, as Mr. Jackson termed it, was first used at Cleveland, in September, 1911, 0.8 part per 1,000,000 were used. This was on the border line of causing taste and odor and the rate was reduced to 0.5.

The possibilities of using liquid chlorine instead of hypochlorite of sodium were discussed by Mr. Jackson and considered promising. The liquid chlorine, compressed from gas and marketed in 100-lb. drums, can now be had at 8c. per lb., and when demanded in larger quantities, the price will be only 6c. The latter is but 50% more than that of an equally effective amount of bleaching powder, a difference of small moment in view of the low cost of the latter, and the advantages of liquid chlorine, which can be ingested into the water without special mixing apparatus, produces no sludge, and is more effective in cold weather than is bleaching powder. As to the electrolytic production of sodium hypochlorite at Cleveland, Mr. Jackson could see no advantage in this, even with salt at 0.1c. per lb., and electric current at 1 to 1½c. per kilowatt-hour.

Taking up typhoid fever at Cleveland, Mr. Jackson said that figures for seven years past show that not more than 10% of the Cleveland typhoid is due to the water supply. Of the remainder, at present, he attributed 10% to out-of-town cases, 5% to raw foods, 30% to general unsanitary conditions, and 45% to contact cases.

Much of the typhoid charged to water supplies in other American cities, and particularly in the South, is due to other causes. At Jacksonville, Fla., a remarkable reduction in typhoid was made in 1911 simply by screening privies, houses

and food supplies, and using chloride of lime in privies.

HYPOCHLORITE TREATMENT AT KANSAS CITY—A few figures on this subject were presented by the secretary from a paper sent by S. Y. High. The cost of the treatment, not including capital charges, is 30c. per 1,000,000 gal. A marked reduction in typhoid has followed the uses of hypochlorite, which is applied to settled water.

Dr. J. L. Leal, of Paterson, N. J., stated that since hypochlorite was first used at Boonton, N. J., in 1908, it has been employed regularly on 300 supplies and in emergencies on 100. It is now a most important adjunct to filtration, and makes mechanical preferable to slow sand filtration.

Reverting to remarks by Mr. Jackson and others on water supplies being responsible for only a small part of the typhoid fever which prevails in many cities, M. N. Baker, of New York, urged that health departments should be held responsible for ascertaining the facts as regards typhoid distribution and applying such of the remedies as fall in their domain. President Gwinn requested Mr. Baker to frame a resolution on the subject.

The resolution, which was adopted, was as follows:

RESOLVED that the American Water Works Association urges upon boards of health the importance of ascertaining and recording the distribution of typhoid fever by causes or modes of infection, to the end that a division of responsibility may be made between water supply, contact cases, general unsanitary conditions, milk and other food supplies liable to contamination, and typhoid carriers; AND BE IT FURTHER RESOLVED that boards of health be urged to do their full duty in the elimination of all causes of the spread of typhoid fever, including the use of polluted private wells or other polluted water when a pure public water supply is available.

WATER WASTE AND SEGREGATION OF CONSUMPTION—Edward S. Cole, of New York, read a brief paper on this subject, which was well received. He divided water losses into pump slippage, underground leakage, plumbing deficiencies, misuse and surreptitious use. Many instances of heavy underground leakage were cited. He advocated the segregation, by proper records, of domestic and manufacturing uses, as an aid in determining whether the total water consumption of a city is unduly high and if it is, where the cause lies. Considerable discussion ensued, mostly in the nature of instances of high slippage, leakage, etc. A committee on tabulation was authorized, primarily to collect and tabulate the water consumption of various cities. The idea was that this and other information, when ready, should be turned over to the secretary for use of inquirers, and that members receiving inquiries would refer them to the secretary for answer.

Allied to Mr. Cole's paper was one entitled, "Methods and Cost of Leakage Survey, at Lancaster, Penn.," by F. H. Shaw. A suggestion that meters would be more efficient and economical and less objectionable to householders than house-to-house inspection, was made by Robert J. Thomas, of Lowell, Mass., who stated that in Lowell, where 78% of the taps were metered, the consumption is less than 50 gal. per capita, and considerably less in total quantity than it was ten years ago. He hoped to do still better in the future and was inclined to make a survey for leaks.

TO WHAT DEGREE MUST SEWAGE BE PURIFIED?—Chester G. Quigley, Trenton, N. J., discussed this subject at length, from the general viewpoint of state boards of health called upon to pass on sewage-disposal plans, and of boards that are inclined to insist on a considerable degree of purification—at least as an ideal for the near future. However, the possibility of calling for over-purification, economic aspects considered, was recognized. Engineers inexperienced in sewage treatment are liable to call for more purification than is necessary, and some state boards of health have adopted the principle of never suggesting that plans be so modified as to call for less purification than they propose.

After stating that the point is being approached where bacterial purification rather than the prevention of unpleasant sights and odors is sought, Mr. Quigley took up some of the governing conditions where disposal is into the ocean, into bays and sounds, into rivers and into brooks. Disposal by dilution was recognized as permissible in many cases, though a far look into the future was advised. Disinfection of sewage was held up as feasible where needed.

It was urged by M. N. Baker that the subject of sewage disposal be viewed broadly, in its relation to other municipal needs, particularly others relating to health.

OTHER PAPERS—A number of other papers on the program must be dismissed with brief mention. F. M. Griswold, a representative of some of the fire-protection interests, explained the national standard for hose couplings and hydrant outlets, and reported their adoption by some fifteen associations, including the various water-works associations.

A paper describing a continuous settling reservoir for Muskogee, Okla., by Alexander Potter, New York City, will be abstracted in these columns later. The reservoir has a capacity of 6,000,000 gal., is of reinforced concrete, is divided into two compartments, and is operated on the continuous plan. Provision is made for removing the sediment from the first and smaller compartment while the reservoir is in operation. To do this, a perforated tile drainage system, controlled by valves, is used.

Laying submerged cast-iron Ward pipe for two relatively narrow stream crossings, at Rome, Ga., was described by M. L. Worrell. The pipe was laid from rafts or pontoons. On test, the first crossing was found to leak heavily. This was attributed to excessive joint deflection. After reducing the latter to 12 deg., filling the bottom of the narrow channel of the stream with stone, the leakage became very small. A member recited an incident which led him to advise flanged joints, with a knuckle joint every three joints, which can readily be detached, removed and repaired.

A water-softening plant recently installed at Owensboro, Ky., was described by E. H. Breidenbach, of that city. Lime and soda are used, at a cost of $3.95 per 1,000,000 gal. for chemicals. The total cost of softening 242,000,000 gal., not including interest and depreciation, averaged $6.58 per 1,000,000 gallons.

A volunteer paper, by Mr. McLain, of Edmonton, Alberta, told of some of the difficulties incidental to water works in a town of phenomenal growth in a very cold winter climate. Mains are laid with their tops 8 ft. beneath the ground surface. All services are metered.

QUESTION BOX

In the good old days of the association, a Question Box was a feature of each convention. This has continued as a sort of vermiform appendix. An attempt at its revivication at the Louisville convention was so successful that at times it promised to displace everything else on the program. Thirty numbered questions were printed on a neat folder and mailed to members before the convention, with a request to "come prepared" or send "written answers."

Among the questions which, when called, elicited no response, were: "Is municipal ownership a success," and "Is the purchase of coal by B.t.u. preferable to purchase by weight."

Interest was shown in a question as to the practicability of using steam generated by a refuse incineration plant to pump water by steam power. Theodore A. Leisen, chief engineer of the Louisville water works, said he was prepared to give the subject favorable consideration, but for some reason the board of public works dropped that as a scheme of garbage disposal. Manager W. Z. Smith, of Atlanta, stated that there was now under consideration in that city a proposition to build a refuse destructor of 250 tons capacity, generate electricity from steam raised by the destructor heat, and transmit the current seven miles to the city water-works pumping station. Messrs. Rinker and Hooker, of Minneapolis, told of the very recent installation of an electric-lighting plant to utilize 200 hp. of waste steam from the garbage furnace of that city.

M. N. Baker, of New York, called attention to the fact that the whole question is one of comparative cost of power

from refuse and from coal or hydro-electric plant, and varies with such local conditions as length of garbage haul, cost of fuel, cost of available electric current; and must also, from the garbage-disposal side, be compared with the possibilities of reduction. He urged that an engineer skilled in garbage disposal be consulted in all cases, lest laymen council committees or water-works superintendents not versed in garbage disposal be led astray by some attractive but possibly chimerical proposition to get something for nothing. Alexander Potter, of New York, remarked that the added capital charges and operating expenses on a garbage incinerator with provision for heat utilization, might increase the cost to $1.50 per ton handled, over 50c. for plain burning. [It should be added that competent engineering advice, it is stated, was secured at Louisville and at Atlanta. The same may have been the case at Minneapolis.]

A flood of discussion was precipitated when two harmless questions on methods of controlling large private water services at times of fire were, by general consent, almost immediately turned into the single question, should there be a charge for private water services for sprinkler fire-protection systems. At first an innocent question, "what cities make no charge?" brought out so many instances of free service that it began to look as though the chief delight of water-works superintendents (municipal plants) was to supply water without money and without price.

It was gradually brought out, however, that nearly all these free-water services were accompanied by frequent inspections or special meters to detect the use of water for other than sprinkler service. Later, one long-suffering superintendent after another gave vent to his pent-up feelings until the convention hall resounded with applause as example after example was cited to show that no manufacturing corporation was too great or too wealthy, and no business man of too high standing for morality and reputed business integrity to prevent the stealing of thousands of dollars worth of water from private fire services unless the water is metered. Particular stress was laid upon the fact that since the sprinkler service greatly reduces insurance rates (sometimes from $3.60 to $0.60), there is every reason why the water should be paid for. Attention was called to the serious danger to life caused by permitting interconnections between polluted private water supplies and city mains, as experienced a few years ago at Lowell, Mass., and but recently at Rockford, Ill. (40 typhoid deaths in the latter case).

The newly elected president, Dow R. Gwinn, of Terre Haute, Ind., summed up the argument for the non-free-water side by saying that it was the duty of the water-works superintendent to show that he, and not the fire-insurance interests or a local manufacturers' bureau, was running the water works.

The cold weather of the past winter led to a number of questions, but there was little attempt to answer these, owing to lack of time and a proposal, which was adopted, that written answers be solicited by the secretary.

The wisdom of providing for state sections and of divisional sections (laboratory, etc.) of the association, was brought up through the Question Box and discussed at length, both kinds of sections meeting with general approval on the floor. It was voted, as the sense of the convention (but only some 35 members were present) that such sections are desirable, and the executive committee and the committee on revision of the constitution were requested to do all in their power to make them possible.

Committee Reports

No less than 15 committees were scheduled for reports. Nearly all the reports were short and unimportant; some do not need mention.

Executive—This committee reported that the National Fire Protection Association had served notice of increase in dues from $15 to $25 a year, and advised that membership be discontinued. The report was adopted.

Finance—The receipts for the year were about $4000, and the cash balance at the close of the year was $457, or considerably more than the balance a year ago. There were no unpaid bills on Apr. 14, 1912, but the delay in printing the annual Proceedings for 1911 will throw most of the expenses for that volume into 1912.

Publication—Hardly a paper had been presented to the committee in time for examination and abstract, as called for by the constitution.

Specifications for Wrought-iron Pipe—A. A. Reimer, chairman, of East Orange, N. J., asked that the committee be continued and its duties broadened to include steel as well as wrought iron, but limited so as to include only welded tubing 4 in. or less in diameter. The request was granted, with the understanding that the committee would make extended studies along lines mentioned by Mr. Reimer.

Depreciation—In the enforced absence of Leonard Metcalf, chairman, it was stated by John W. Alvord (Chicago) that a final report was not yet ready.

A lengthy discussion on various phases of depreciation ensued, in the course of which the well established general principles governing depreciation were forcibly explained and urged by a number of members. A strong appeal was made to managers of municipal plants to charge off depreciation and to so frame their water rates that an actual depreciation fund would be provided. Mr. Alvord tellingly remarked that writing an allowance for depreciation on a piece of paper and waving the paper in the air does no good whatever.

Questions were raised as to whether the 2% of depreciation reported as charged off at Cleveland, Ohio, and 1% or more at Auburn, N. Y., amounted to more than bookkeeping entries. Doubt was expressed as to whether either private or municipal plants could actually earn operating and maintenance expenses, taxes and 2% for depreciation at prevailing rates. Several references were made to the Knoxville decision in the U. S. Supreme Court, to the effect that depreciation for past years, once neglected, could not be charged off in arriving at a basis for current rates.

From depreciation the discussion wandered into various more or less closely related phases of rate making, the burden of which was a contention on one side that in fairness to private plants in particular, and to water consumers and taxpayers, rates for municipal plants should be high enough to meet operating expenses, rent, the taxes a private plant would have to pay, and depreciation. This seemed hard doctrine to some of the municipal men, but there was gratifying evidence that the underlying principles of fair rate making for both private and public plants are gaining recognition.

Uniform Accounts—The scheme for uniform water-works accounts reported by the committee a year ago and since printed and circulated, was adopted by the association. The plan has the general approval of several other associations and the Bureau of the Census.

National Bureau of Health—No formal report was made. The committee was continued on the assurance of its members that the successive bills for a federal bureau of health have given increasing promise for the recognition of engineers and engineering principles, as well as consideration of the prevention of water pollution, if once a bureau is established.

Electrolysis—Dabney H. Maury (Peoria, Ill.), stated that his committee still adhered to the conclusions of its report of two years ago. The full decision in the Peoria case was appended to the report.

Revision of the Constitution—A thorough and radical revision is planned, Mr. Maury reported. A draft will soon be submitted to the executive committee and, it is hoped, mailed to the members for discussion.

Incorporation—Power to incorporate was continued.

Water-Works Standards—The committee was discontinued, in view of the existence of two other committees on standards.

Permanent Headquarters—It has been ascertained that for $1000 to $1200 a year a room could be rented in the En-

gineering Societies Building, New York City. This sum, plus the salaries of a full-time secretary and stenographer, would be beyond the present financial ability of the association. Various plans of providing the funds needed had been considered. Rather than call on associate members and outsiders for subscriptions, it was thought best to take steps to increase the active membership, and, if necessary, to increase the dues. The report was ordered spread upon the minutes without action as to the suggestions, further than implied acquiescence in the opinion that for the present permanent headquarters are financially impracticable.

General Business

Election of Officers—The usual pushing of vice-presidents up the presidential ladder took place. Dow R. Gwinn, of the Terre Haute Water Co. (Ind.), thus became president, the four remaining vice-presidents (R. J. Thomas, J. A. Affleck, George G. Earl and T. A. Leisen) were each advanced without contest, while Charles R. Henderson, of Davenport, Ia., was elected by a large majority over two other nominees. John M. Diven (Troy, N. Y.), was reëlected secretary without opposition.

Minneapolis in 1913—By a rule adopted at an earlier session, much high-sounding oratory was cut off when it came to choosing the next meeting place. The choice was: Minneapolis, 101; Richmond, 61; Birmingham, Ala., 9. It will be noted that for meeting place (associate members or supply men voting) a total of 171 votes were cast, while for fifth vice-president the total vote was 39.

Officers of Water Works Manufacturers' Association—This association is composed of associate members of the main organization. It elected officers as follows: President, W. H. Van Winkle, Water Works Equipment Co., 50 Church St., New York City; Vice-President, Wm. C. Sherwood, Hersey Manufacturing Co., Boston, Mass.; Treasurer, Robert E. Milligan, New York Continental Jewell Filtration Co., 5 Broad St., New York City; Secretary, Ernest K. Sorenson, New York Continental Jewell Filtration Co., 15 Broad St., New York City.

Entertainment

It would not be wide of the mark to say that the entertainment began with and on the special train which ran over the Pennsylvania R.R., starting from New York Sunday morning. A unique feature of the trip was a rainbow just as the famous horseshoe curve was reached.

During the convention a variety of entertainment was provided by the local committee, the Water Works Manufacturers' Association and, last but not least, the U. S. Cast Iron Pipe & Foundry Co., which gave all members and guests who could and would go a trip to the great Mammoth Cave. By some hocus pocus, the announcement of this trip was not made on the convention program, so some who would gladly have taken it could not do so, owing to previous engagements. It was generally understood that the fault was not due to those who gave the trip, nor to the association proper, except in so far as the latter had inadvertently let the control of its program pass out of its own hands.

Notable features of the entertainment, which also partook of the instructive, was a carriage drive to the river pumping station of the Louisville water works and later a trip to the filtration plant. At the latter, a lunch was served by the city water department.

The Philosophy of Purchasing Supplies*

By Elihu Cunynham Church†

About ten months ago I was directed to reorganize the Bureau of Supplies for the Water Department of New York City, and in carrying out the work I have attempted to formulate the principles governing the problem. Briefly stated they are: Get the right materials in correct quantities at the lowest price.

Getting the Right Materials—Many requisitions fail to describe properly the quality of the material needed. There is a tendency to order the highest grade obtainable when the goods are not to be paid for by the man doing the ordering; this is especially true as men seem to feel that it relieves them from responsibility for any subsequent failure of the articles when in service. It is an expensive habit, and except in rare cases requisitions should be filled with articles of the standard commercial grades.

Getting the Right Quantities—Requisitions as received must also be carefully considered to ascertain if the quantities called for are proper; for unless there is an inventory of material on hand one may easily purchase supplies of which there are plenty in stock. I have found that new orders are often based on the orders of previous years irrespective of whether materials so ordered were used and without considering that conditions and requirements have changed in the meanwhile. To this end an inventory of the property of the department is being taken and wherever possible requisitions are filled from stock on hand.

Storage and Care of Supplies—The storage and use of all goods should also receive the careful scrutiny of the bureau of supplies for it is inconsistent to keep accounts of money with great accuracy—and then when the money is invested in stores pay no attention to whether they are used or wasted. Improper storage often results in excessive depreciation. Supplies should be issued in rotation; for when stores are issued in the order in which they are received no old material is left on the back of the shelf to deteriorate and subsequently be thrown out. To carry these ideas into effect storehouses are being fitted up at central points, and a number of specially trained men have been installed as store-keepers.

Consumable and Non-consumable Supplies Compared

I have also divided all supplies into two classes, consumable and non-consumable. Fuel, oil, waste, and lumber are examples of the first class, whereas tools, implements, rubber boots, etc., belong in the second group. As soon as possible it will be arranged that none of the non-consumable supplies will be issued till those they are to replace have been turned in. Thus a man cannot procure a new tool till he has returned the old one and shown that it was worn out.

Specifications—The problem of obtaining the "right material" brings the question of specifications to the front. Multiplicity of styles and types is a disadvantage, and simplification is greatly to be desired and sought after. To this end investigations and tests are now being made to determine and establish the standards of quality to be met by the various materials purchased.

Getting Low Prices—In order to obtain low prices a number of things are necessary. First it is essential to have as much competition as possible. To bring this about lists have been prepared giving the names of the firms making the various classes of goods, and then we notify them when we are in the market.

Supply contracts are now so drawn that goods in different groups or divisions, as determined by manufacturing specialization or trade usage, may be bid on separately; for if orders are drawn to contain goods of different classifications the bidders will be "middle men" and "commission merchants," not the makers of the wares nor the regular dealers in the various subdivisions in which supplies are customarily bought and sold.

In order to interest the manufacturers and get them to bid it is necessary to purchase fairly large quantities at a time. To do this the department now buys its supplies [except for emergencies] every three months and these new quarterly contracts contain sufficient goods in each class to enable the makers to quote wholesale prices.

Another advantage of quarterly contracts is that where goods are bought in quantities, all to be delivered to some central storehouse, the proportion of the

*Condensed from a paper read before the American Water Works Association, June, 1912.

†Secretary of the Department of Water Supply, Gas and Electricity, and Acting Chief of the Bureau of Supplies, Park Row Building, New York City.

cost chargeable to delivery becomes very small.

Every effort is made to reduce the time which it takes to canvass bids, notify the low bidders and award the contracts, for delay in this respect might cause loss and inconvenience due to possible changes in prices and market conditions.

The new methods have so simplified matters that on the average the time required after the delivery of supplies to inspect them, audit the bills and forward the bills to the comptroller for payment has been reduced from many weeks to less than eight days.

Floor Area as a Basis for Estimating Water Consumption*

By William W. Brush†

In 1908 the writer was placed in charge of the general design of the delivery system to carry, to the five boroughs of Greater New York, the 500,000,000 gal. per day which would eventually be available from the Catskill reservoirs, this work being carried on by the Board of Water Supply. Studies in connection with the design of this system required a determination of the existing consumption in each borough, and in subdivisions of each borough, as well as an estimate of probable future growth in consumption.

It was found that the measurements of flow that had been made were not sufficient in extent to give a fair basis for estimating the present consumption in the various sections of the city, and that a per capita basis for consumption was practically useless for this purpose for the Borough of Manhattan, due to the fact that large areas are wholly devoted to office buildings, manufacturing and other business purposes; and also on account of the rapid changes going on in the elimination of buildings previously used for residences and the substitution of office buildings, lofts and factories.

To carry out the work required to satisfactorily design the Catskill delivery system, some unit of consumption was necessary that did not vary to the extent of the per capita unit and that could be applied to business as well as residential sections. An investigation of the available data on which to estimate future as well as present consumption, showed that the area occupied by buildings would be the fundamental basis for future consumption, especially in the Borough of Manhattan, and that, other things being equal, the amount of water used in any building would be dependent upon the ground area covered and the number of stories in height. It was therefore decided to study the use of the floor-area unit as a basis for estimating consumption. The floor area was to be determined by multiplying the ground area of a building by the number of stories, allowing one additional story for basement or cellar. One thousand square feet of floor area was found to be a convenient unit, and one that would give a resultant consumption averaging about three times that figured on a per capita basis. There was no record that the floor-area unit had been previously used in other cities and therefore no data were available for comparison of results obtained by the use of this method in New York City, although in a few instances the consumption had been determined for the ground area covered by buildings. The consumption per service, consumption per fixture, consumption per unit of length of main, and consumption for other units have been computed in special cases.

The main reasons for adopting the floor-area basis for New York City are summarized as follows:

The amount of water used in any building is proportional to the size and height of same.

The total floor area could readily be obtained from available atlases.

Very large areas, especially in the Borough of Manhattan, are occupied only for business purposes.

A large and increasing part of the population, especially in the Borough of Manhattan, is transient, and, therefore, cannot be accurately determined for the present nor for the future.

Several hundred thousand people in Manhattan, engaged in business, make their homes in adjoining sections of New York State and New Jersey.

To determine the present use of water per unit of floor area, typical buildings were selected in which the supply was measured by meters, and the resultant consumption determined. There were also available measurements of various districts in Manhattan, Brooklyn and The Bronx, which were made by use of the pitometer during waste investigations carried on in 1902-03. The accompanying Table I gives the results of these measurements, as well as those taken in 1911, a reduction in consumption in 1911 of about 15% having been effected by house-to-house inspection, while in 1902 no special work had been done on water-waste prevention.

With a variation in the per capita consumption of from 37 to 860 gal. daily, it was evident that it would be difficult to apply a per capita basis to different sections of the city to determine the consumption in such sections.

It was found, upon examination, that, with the exception of those buildings where the consumption of water would be unusually high, such as hotels, laundries, ice plants, etc., the use of water per 1000 ft. of floor area was 150 to 300 gal. per day. This covered only those buildings used for business purposes, as, under the rules of the water department, meters are not required in buildings used for residences. It was anticipated that apartments of the higher class would show a somewhat larger use of water per unit of floor area than would the tenement class, and that both would show a larger use than private residences. The first computations made of consumption in districts which covered several blocks, included a high-class apartment house and hotel section in the vicinity of 80th St., on the west side, and a low-class tenement section on the east side in the vicinity of 80th St. The per capita consumption in these two districts was 154 gal. per day and 37 gal. per day, re-

TABLE I. SHOWING GAGINGS, 1902-03

No. of district	Characteristics of occupancy	Consumption, million gal. per day	Population, resident	Consumption, per capita, gal.
1	Large hotels, high-class residences	1.87	8,396	223
2	East-side tenements	1.44	38,906	37
3	East-side tenements	5.40	90,000	60
6	Residence and high-class apartments	0.76	10,164	75
8	Business, office buildings, waterfront, shipping	9.45	11,000	860
9	High-class apartments and hotels	1.37	8,872	154
10*	East-side tenements, some waterfront	20.20	218,023	93
11	Uptown residences and medium-class apartments	4.89	4,380	112
12	Upper east-side tenement, waterfront, power houses and breweries	2.75	39,969	69
	GAGINGS, 1911			
1a	East side tenement, some waterfront (same as district No. 10)	11.44	230,500	50
2a	All classes	29.48	204,557	144
3a	High-class apartments and residences	22.18	186,990	118
4a	High-class apartments, residences and tenements	12.74	138,800	92
5a	East-side tenement and waterfront	8.28	84,580	98
6a	High-class apartments, residences, tenements and waterfront	14.82	173,000	86
7a	All classes	13.38	169,100	79
8a	All classes	13.66	209,393	65

*An error was later discovered in the measurement of flow in this district, which reduced the consumption as given by about 50%.

TABLE II

Section	Average height of building, stories	Percentage of block built upon	Consumption per 1000 sq.ft. of floor area, gal. daily
South of 23d street	8	85	350
23d to 46th street	10	85	350
49th to 59th street	8	85	350
59th street to Spuyten Duyvil	6	75	300

*Somewhat condensed from a paper read before the American Water Works Association, Louisville, Ky., June, 1912.

†Deputy Engineer, Department Water Supply, Park Row Building, New York City.

spectively, the high-class apartment district therefore showing a consumption, on per capita basis, of over 400% of that shown for the tenement-house district. On the floor-area basis, the figures for these two districts were 181 and 179 gal. per day per 1000 sq.ft., respectively, or a variation of less than 2% between the two districts. While this close agreement in consumption for the two districts was a coincidence, it strikingly illustrated the uniformity obtained from the floor-area basis as compared with the per capita basis in two residential districts where the character of population varied widely.

As further studies showed the floor-area basis to be a practical one, it was applied generally to the Borough of Manhattan. The ground area was scaled from the atlas, and this area multiplied by the number of stories, the buildings being grouped as far as possible to reduce the labor. It was found that it required the equivalent of about one man's time for four months to determine the floor area for this borough, the area in each block being estimated separately. After the entire area of the Borough of Manhattan had been determined, the average consumption was computed and proved to be about 300 gal. per 1000 ft.

To determine the prospective use of water in the Borough of Manhattan, the area available for buildings was determined, eliminating street and park areas, and the borough was divided into four groups, the average height of building and percentage of ground area to be built upon in each group being estimated. The future consumption per 1000 sq.ft. of floor area was taken as 350 gal. for that section of the city lying below 59th St., to provide an ample margin of safety in the estimates. Table II gives the units adopted.

These figures gave an ultimate estimated consumption of 835 million gallons per day.

In addition to estimating the ultimate consumption in the Borough of Manhattan, the present and prospective use of water in the various sections of the borough were estimated, as a foundation for studies of the size of connections for the new Catskill aqueduct.

The experience of the past three years has shown that the floor-area basis is useful also in the following work:

To determine what is the reasonable consumption in districts which are being surveyed by use of the pitometer, thus determining whether further investigations to detect leakage are advisable.

To determine consumption in individual blocks, or groups of several blocks, where it is proposed to extend high service to cover districts previously supplied from low service.

To determine whether metered consumption indicated for large buildings is probably correct, where question has arisen as to the presence of illegal connections.

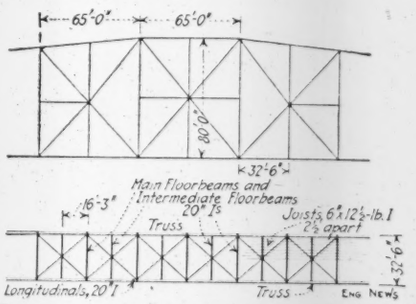
To determine size of tap that should be granted for a new building.

The per capita basis for estimating consumption is the most practical one for general use, and will undoubtedly continue to be the standard unit. Experience with the floor-area basis in New York City has shown, however, its usefulness in water-works operation, and it is believed that other cities than New York will find occasions where it can be utilized to advantage.

Economic Panel Lengths for Long-Span Highway Bridges

By H. G. Tyrrell*

The selection of an economic length of truss panel is an old problem, and as far as the truss itself is concerned it is easily solved. The difficulty arises when it becomes necessary to select a panel length which is the most economical for both truss and floor system. The case is still quite simple for short-span highway bridges, where a length (12 to 16 ft.) which is suitable for floor joist is likewise long enough for the truss. But for a long-span bridge the economical design must have a combination of long panels for the truss and short ones for the floor system.



Sketch of Floor System with Intermediate Floor-beams

The master bridge engineers of former generations attacked the problem in various ways. The most favored plan was that in which double web systems were used in the trusses, giving diagonal inclinations not exceeding about 45°, as in the Whipple truss. Double systems were very generally used until 20 years ago, for spans up to 400 ft. and truss depths up to 50 ft., as in the Bismarck bridge over the Missouri River, designed by George S. Morison, in 1883, or in the Nebraska City bridge.

The problem is simpler for railway bridges with riveted stringers and panel lengths of 25 to 30 ft. than it is for highway bridges, where panels can rarely exceed 16 to 20 ft. Since 1888, when the Cincinnati railroad bridge over the Ohio River was completed, with spans of 550 ft., from plans by Mr. Burr, a number of other long-span railroad bridges have been completed, most of them with truss outlines similar to that at Cincinnati. But in 1904, when the writer was called upon to design a highway truss span approximately 600 ft. long, it became necessary to determine the economic panel arrangement for such a span, giving at once the economy of long panels in the truss system and short panels for the floor.

The economic truss depth for a span of 600 ft., with the loads that were assumed, was 80 to 90 ft. For single-truss system the length of main panel should therefore not exceed 60 to 70 ft., in order that diagonals should not lie at too flat an inclination. Main panels 65 ft. in length were therefore selected, and these were divided by suspenders from a center intersection, making truss panels 32½ ft. long. Comparative estimates were then made for different floor systems: (1) 15-in. beams 3 ft. apart; (2) lines of riveted steel girders 5 to 6 ft. apart, overlaid with cross-beams and plank; and (3) two lines of longitudinal 20-in. beams, one at each side of the bridge adjoining the truss, supporting an intermediate floorbeam the same depth as the side beams (thus dividing the floor lengthwise into 16-ft. panels), carrying 7-in. steel longitudinals 2½ ft. apart to carry the plank. The last method proved to be economical and was therefore adopted. In addition to supporting the intermediate floor-beams, the two side lines of 20-in. beams acted with the eye-bars as supplementary chords for the lateral system. Trusses were placed 32½ ft. apart, thus making square floor panels.

At that time, and for six years afterward, the bridge continued to be the longest simple-truss span.

*Consulting Engineer, 540 Judson Ave., Evanston, Ill.

The Evil of Sulphur in Steel has been exhibited in a new way in some valuable experiments made by F. Rogers, which he reported recently to the Iron and Steel Institute (May, 1912). With a view to investigating the characteristics of a piece of steel at its fracture, when it is broken by some accident or through the effect of an internal flaw, he devised a method for making contact prints of fracture faces. His prints are similar to contact sulphur prints heretofore taken of polished surfaces of metals, but his method adapts this method of printing to the irregularity of face of a fractured surface. He uses a molding clay made of vaseline and wax, and coats its face with a silver bromide emulsion. This is soaked in very dilute acid and then pressed against the fracture face for a few seconds, which makes the chemical print on the film; the print is then either rinsed or fixed in hyposulphite. In applying this method it was found that the printing takes place at an enormously greater speed than printing from a cut surface very close to the fracture (in fact as close as it could be cut). The regularity with which this phenomenon is observed indicates to the author that the fracture makes its way through the minute sulphide specks which are in the metal. The remarkable fact is that this occurs even with steel containing less than 0.04% sulphur, although many persons claim that there is no practical difference between different percentages of sulphur in such low amounts.

Letters to the Editor

Computing the Size of a Reservoir Spillway

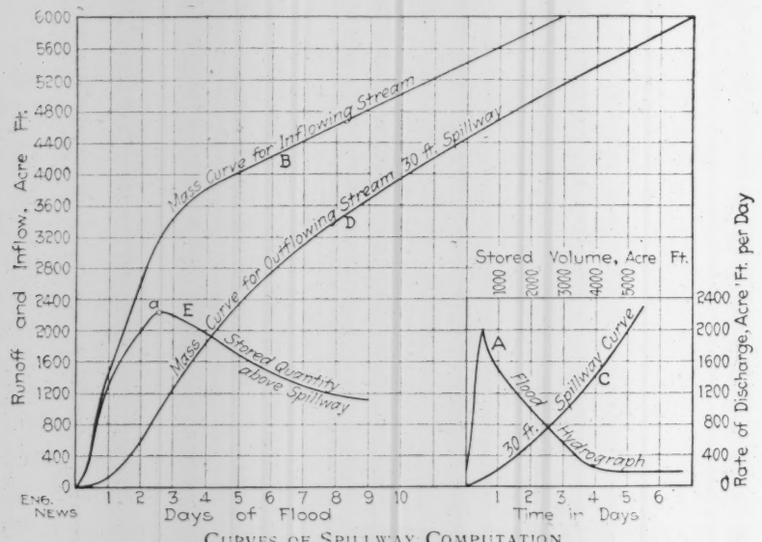
Sir—In your issue of Mar. 21, 1912, p. 524, H. K. Palmer gives a method for computing the dimensions of reservoir spillways. With this method much computing and measurement of areas is necessary. The following graphical solution of this problem, evolved by the writer, is believed to be simpler.

A typical flood-wave for the stream in question is first determined from existing hydrographs or by comparison with streams of similar characteristics. (Most of the streams of the Southwest, for instance, have similar flood characteristics; the stage rises very rapidly to the maximum point, remains at that point for a very short period, and recedes less abruptly, finally becoming normal in the course of a few days). In any study for a reservoir spillway, a typical wave should be drawn, with the crest well above the highest known stage, and its duration prolonged beyond that of any previous flood (curve *A* in sketch herewith). From this flood wave a mass curve is drawn with runoff in acre-feet as ordinates and time in days as abscissas (curve *B* in sketch).

The reservoir storage capacity for each foot above the spillway must be determined from a topographical map; the rate of increase will in general not be constant as assumed by Mr. Palmer. From these data a curve is plotted with stored water as abscissas and rate of discharge in acre-feet per day as ordinates, for any assumed length of spillway. This may be called the "spillway curve" (curve *C* in sketch).

A mass curve of water discharged from the spillway is now constructed as follows: The spillway discharge is assumed to be constant for the interval of time taken, say one-fifth day. For the first two or three intervals the total quantity discharged by the spillway will be very small, so that the values for stored water are taken directly as corresponding ordinates of the flood mass curve. These are used as arguments in taking out the corresponding spillway discharges from the spillway curve, each of which (multiplied in this case by 0.2) gives the increment for the mass curve of spillway (curve *D* in sketch). The error involved for the first few points is inappreciable. Once the spillway mass curve is started it can be approximately projected ahead through the following interval, and the mean ordinate of this (approximate) curve for the interval, subtracted from the corresponding ordinate of the flood mass curve (curve *B*) gives the argument from which the spillway discharge for the interval is taken from the spillway curve (*C*). Thus each point on the spillway mass curve can be determined in succession, as accurately as can be plotted, at one operation. After the curve has passed its point of maximum curvature a longer interval can be used without appreciable error.

From the two mass curves a curve *E* giving directly the quantity of water stored can be drawn, its ordinates being equal to corresponding ordinates intercepted between the two curves.



CURVES OF SPILLWAY COMPUTATION

From the curves now obtained, any quantity desired in the problem can be taken off directly, such as maximum quantity of stored water, spillway discharge at any time, time when flow over spillway becomes (approximately) equal to inflow, and various other quantities that might be required.

Other curves can readily be drawn for any other spillway lengths, without computation, on the same sheet, thus facilitating comparison. The only computations involved are in constructing the first spillway curve.

C. C. JACOB, Junior Engineer,
U. S. Geological Survey.
Mesa, Ariz., Apr. 4, 1912.

Ferryboats Propelled by the Current

Sir—The description of the current-propelled ferryboat on p. 1011 of your issue of May 30 might give some of your readers the impression that this interesting device is new and novel. The fact is that such ferries have been in common use, in the South at least, for a long time. I can personally testify to the existence of quite a number of them more than 30 years ago.

S. WHINERY.
New York, May 31, 1912.

[Others beside Mr. Whinery seem to have felt some concern lest current-propelled ferryboats might be so unfamiliar to some of our readers that the one at Clarksville would be looked upon as unique. C. J. Stolbrand, of Brooklyn, N. Y., who was formerly a lieutenant in the Corps of Engineers, says that the "flying ferry" dates back to the advent of the pontoon into our army and that a description of one is given in the manuals of the Engineer Corps. Mr. Stolbrand took part in the building of one of these ferries at West Point in 1904.

The record of low maintenance cost of the Clarksville ferry is its chief feature of interest. This low cost justifies drawing renewed attention to this old but now infrequently used device.—ED.]

Self-Appreciation by Public Employees—During the year the board has maintained for the sake of convenience, two divisions of its force, one termed the railroad division and the other the utilities division. Each division compromises a chief and three assistant inspectors. (From report of Board of Public Utility Commissioners of New Jersey for 1911.)

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. RON'T MCKEAN, Sec'y.
505 Pearl St., New York.

Monadnock Bldg., Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

CHARLES WHITING BAKER, Editor.

Subscriptions payable in advance, $5.00 a year for 52 numbers, including postage in the United States, Mexico, Cuba, Porto Rico, Hawaii, or the Philippines, $7.00 in Canada.

To foreign countries, including postage, $9.00 or its equivalent, 36 shillings: 36 marks: or 45 francs.

Notice to discontinue should be written to the New York Office in every instance.

Advertising copy should reach New York Office by Thursday of week before date of issue.

Entered at New York Postoffice as mail matter of the second class.

CIRCULATION STATEMENT

During 1911 we printed a total of 931,958 copies.

Of this issue, 18,500.

None sent free regularly, no returns from news companies, no back numbers kept beyond current year.

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Engineering News

The Mississippi River Flood of 1912

We commend to our readers' careful study the very valuable and complete article by A. L. Dabney published in this issue of ENGINEERING NEWS. The control of the lower Mississippi River is an engineering question and it is one on which it is very desirable that the engineering profession as a whole should be fully informed. In this, as in other important questions of public interest, it is the duty of engineers as a whole to act as a leavening influence in the formation of public opinion, so that the public shall not go astray in its judgment on these matters, with disastrous results.

Further than this, it is important that every engineer, in whatever branch of the profession he is engaged, should understand and should do his share in making the public understand that the floods of this year on the lower Mississippi are not in any sense the fault of the engineers responsible for the flood protection of that locality. While we have already emphasized this fact in the editorial pages of ENGINEERING NEWS, Mr. Dabney's paper reinforces our conclusion with the support of a large array of facts and figures recording in detail what has actually happened on the river this year.

As one studies Mr. Dabney's article, the impressive thing is that the levee system of the lower Mississippi has given so good an account of itself under the conditions to which it has this spring been exposed. In the whole 2000 miles of levees there were a total of but 22 breaks, and on the east side of the river, in the whole distance between Cairo and New Orleans, only three breaks occurred. When one considers the conditions under which the levees have been built and what they were exposed to, this year, in the way of high water and over-topping, coupled with heavy rain and wind effects, it is remarkable that they have stood so well. It is not to be expected that a structure will do its work and stand the heaviest stresses until it is completed; but all along the Mississippi levees the engineers in charge make no claim that the work is completed, on the contrary they have been steadily working year by year to raise the levees to the higher levels and broader cross-section provided for by the best practice. Mr. Dabney states that in the lower St. Francis district, for example, the engineer in his last annual report stated that the levees of that district were only 60% completed.

Mr. Dabney also emphasizes the fact heretofore pointed out in these columns that all that is necessary to make the lower Mississippi Valley secure against floods is earth levees properly constructed and of ample cross-section. It may be true indeed that there are places along the levee line where underground conditions might dictate the use of sheet piling or some other method of making an impermeable wall below the levee foundation line. Such conditions, however, are far from being typical and there is no necessity of investigating patent schemes for building levees or weird ideas concerning additional outlets, storage basins or reservoirs on the tributaries. Such schemes divert public attention from the main point at issue on which it is important that the public shall have correct and sound opinion. So much work has already been done on the present levee system that it will take only a comparatively small additional expenditure to raise and strengthen it to the point where a flood like that of the present year can be safely carried in the river channel all the way from St. Louis and Cairo to the Gulf.

The Commerce Court and Public Administration

The U. S. Supreme Court this week rebuked the Commerce Court for its assumption of full paternal authority over the Interstate Commerce Commission. The Commerce Court, it is decided, has not the unlimited veto power over the Commission that it attempted to exercise, and its jurisdiction is for the first time defined and limited. The Supreme Court finds, by strict construction of the statute creating the Commerce Court, that this body cannot suspend a negative order of the Commission, i.e., denial of an application. This is highly gratifying, as a step toward marking out clearly the powers of an administrative body, and as placing a limit on the extent to which these powers may be paralyzed by judicial interference. Further extension of the principles back of this decision may perhaps in time curb the rampant tendency to destroy the efficiency of discretionary administrative authorities by excessive application of the judicial-review theory.

The old saying that a patent is of no force until it has gone through the courts may be applied with little change to the actions of regulative boards: their conclusions and directions often prove to be non-enforceable—by virtue of injunc-

tions—until some court has consumed a few years in doing some amateur thinking on the subject. It matters not if the public is exposed to irremediable damage by this delay; the "equity" idea takes account only of alleged irremediable damage to some private interest. It matters not that the court employs in its final determination the same method, discretionary judgment, but without the necessary expert ability, that the regulative board employed; for there is assumed to be a peculiar virtue in conclusions reached by some non-technical lawyer whom the court appoints referee or master, as against the conclusions of a technical board.

The evil is greatest in the case of local-government boards, which appear to have least standing in law courts. In their case the usual unfortunate working out is that any large corporate private interest can escape the board's control, by securing the delay obtainable through the injunction veto. This delay being more often measured in years than in months, it happens that the board's funds for litigation give out, or its term of office expires, or its powerlessness results in loss of public support. In the end, not infrequently, the private interest obtains a victory by default; and in any case it attains its chief object: the long delay.

Railway and utility commissions, boards of health, boards of design, construction or control, may in the future succeed in being recognized as responsible guardians of the public interest. Legislatures may prescribe and courts may accept the principle that decisions made by such boards are *prima facie* evidence of an urgent public necessity or interest, such that the decreed regulation or decision must not be interfered with until clearly proved wrong. These public bodies work slowly enough; when they move to correct an evil the evil is surely bad. The proof should lie on the opposing party to show that the decreed change would work a private wrong greater than the public wrong which it would correct. When (if ever) this view is recognized by the courts, some notorious defects of our governmental methods will be eliminated.

The creation of the Commerce Court removed some sinister influences from our national regulation of railways. The new court, however, promptly acted in a way to suggest that it would create more troubles than it wiped out. It has fairly earned the public mistrust now engaging the attention of Congress, which may possibly result in abolition of the Commerce Court.

If this court is abolished, will a successor be necessary? Nothing now before the public justifies a belief that the Interstate Commerce Commission should have a second body set over it to pass upon facts. Administrative questions must be decided by a single body, and the only thing needed or possible in the way of a check is a review on points of fundamental law. This latter, however, is appropriate to the Supreme Court, or to an equivalent tribunal to deal with questions of law alone. A so called court that undertakes to re-decide the questions of fact involved, already weighed by the Commission, can be only a clog.

A New Soundness Test for Cement

The pressure-boiling test for soundness of cement, recently inaugurated by the Lackawanna R.R. and described on another page in this issue, is essentially a challenge from the engineer-user of cement to the chemist-maker. Cement today is a chemist's product and, with all due deference to the technical societies which are responsible for them, the standard specifications under which cement is bought and sold are chemist's specifications. Certain broad requirements governing the strength and durability of concrete are laid down by engineers. Specifications are then made up which promise to predict from the behavior of cement samples the behavior of well made concrete having this cement as its most important ingredient. As in all testing operations, the variation between small samples and large size structures is very great and efforts are constantly being made to bring the test sample into closer relation to the material as it appears in the structure.

Among the tests on cement concerning which the chemists themselves most disagree is the test for soundness. England, Germany and the United States each has a different final test for the soundness of cement, but the nature of all the tests is to establish by means of tests on cement samples the security against the "blowing" of that cement in a finished structure. A cement which successfully passes these tests is said to be "sound"; but this is a comparative word guaranteeing only the behavior of the cement under the particular test applied. There is danger of this being forgotten and the assumption being made that a cement "sound" by an arbitrary test is bound to make a concrete free from any indications of swelling or "blowing."

The engineers of the Lackawanna R.R. have found that numerous concrete structures built of cement which had satisfactorily passed the soundness test prescribed by the standard American specifications, are now showing signs of incipient failure, which might be well explained by the swelling of the cement in the concrete. The many possible sources of trouble from the stone or the sand or in the manner of building the structure were first investigated, and having eliminated all of these to their best satisfaction the engineers fell back on the cement as the cause of the trouble. As a result of investigations into this question of the soundness of cement, they now propose a new and apparently severe soundness test, confident of being able to produce themselves the good workmanship and aggregate necessary for the integrity of their concrete in the future.

This action has a dual importance. It is not an academic protest against the widely circulated standard tests generally accepted in this country, but one that will annually affect the acceptance of many thousands of barrels of cement for use on one of the large railway systems. Furthermore, it is the first important revolt against a standard soundness test in which the conditions of acceptance have been made more rigid than those already established. In Germany, and to some extent in continental Europe, there has been a campaign, culminating at the Copenhagen Congress of the International Association for Testing Materials, to discard all hot water or boiling tests for soundness and to substitute therefor only a cold-water test. This test alone is now generally required in German practice. We do not know whether the cold-water test guarantees the behavior of a cement in concrete. It is certain that the number of cements discarded as unsound will increase materially with the degree of heat and pressure applied in the boiling tests. To this extent at least the Lackawanna test is a step toward severer specifications.

In the many attacks in the past on the boiling test for cement it has been claimed that this test threw out two good cements for every bad one it detected. Probably it will be claimed that the Lackawanna's new test will throw out even more good cements; but the cement experts who make this claim often forget that from the standpoint of a constructor it is better that ten good cements should be condemned than one bad one accepted. In effect the engineers of the Lackawanna say to the cement makers, "You are the ones who make the cement and in large measure you make the tests for the cement. In our opinion your tests do not reject all the bad material though they may accept all the good. What we want is a test that will reject all the bad material even though some good goes along with it."

Here we have the essential difference in the standpoint of the producer and the consumer.

The engineers of the Lackawanna make no broad claims for their test. They merely offer it as one which will decrease the probability of an unsound concrete. They offer the test to the cement makers with an entirely receptive mind. If it is wrong, they want to know where it is wrong. They want to know why some cement passes it and some does not, but finally, though they are willing to be convinced of its possible

uselessness, until they are so convinced they much prefer to take their chances with the cement that remains sound under the severest test they can devise, particularly when they can find any amount of cement that will pass it.

State Control of Highway Bridge Construction

For many years common practice in the design, construction and contract letting of small public-highway bridges has been notoriously disgraceful. More than 20 years ago many columns of ENGINEERING NEWS were devoted to a frank discussion of the evil and to proposals for its remedy. Bridge commissioners ignorant of all technical matters were then the rule rather than the exception, and bribery and corruption went hand in hand with ignorance. It generally happened that those who were too honest to be bribed were too ignorant to realize the high cost brought about by pooling of bids or to understand the insecure design and construction that saved money for the contractors. Sporadic proposals were made urging the formation of some state body authorized to pass upon all highway bridges previous to contract letting, but the cry of the bridge companies that such a body would be either corrupt, prejudiced or ignorant—all common enough faults of governmental bodies—and the then nation-wide fear of a too-paternal government acted together to kill any such plans. And so the evil was left to work its own cure.

Except among those whose practice brings them close to highway work, the general impression of engineers today is that such a cure has automatically resulted and that these disgraceful conditions are but relics of the past. It would be to the credit of human nature in general and to the builders of small highway bridges in particular if this optimistic view were true; but unfortunately it is not. Anyone who is at all acquainted with conditions in country highway bridge building today, particularly in the Middle West, knows that we still have with us the ancient evil of selling small highway bridges like yards of calico, with no guarantee, with no technical supervision and with no authoritative intermediary between ignorant and often corrupt local officials and the complacent and conspiring bridge companies. About the only change that has taken place is that now there are both concrete- and steel-bridge companies fighting against each other to see which shall mulct the public.

These may sound like harsh charges, but they are based on the statements of a number of engineers of high standing, principal among whom are various State Engineers whose duties of inspection and supervision take them closest to the flimsy structures such conditions produce. Space will not permit the reproduction of all of this testimony here, but the following extract from a recent published utterance of W. S. Gearhart, State Engineer of Kansas, is typical of the evidence:

> The state is divided into districts by the bridge companies, each company having its district in which their bid is generally the lowest, although the other bidders who are present through an understanding or by invitation from the low bidder always puts in a straw bid to make it seem right. The low bid generally includes the following items: Cost plus a profit plus the expenses of the other bidders present. In many counties in the state one bridge company has been doing the work for years.
>
> Many of the county boards let their work privately in violation of the law. And in practically every case of fraudulent contracting the advertising is invariably kept at a minimum and the work let privately. This results in poor economy by allowing a contractors' ring to be formed thereby practically letting all the contracts at abnormally high figures.
>
> In the counties where the contracts are let privately the bridge agent has ordinarily told one or more members of the board confidentially he could give them better prices on their work if it were let without advertising than at public letting, and sometimes he does, but generally not, for the county boards are not able to estimate the cost of steel or concrete work. They can and do only guess at the approximate cost and the bridge salesmen assume no responsibility for their ignorance and lack of experience in bridge design and cost.
>
> The boards permit or request the bridge companies to submit their own plans and specifications, if there are any, and generally depend entirely on their "old consulting engineer" (the bridge agent) for all their information and advice concerning the kind of bridge they should build and its probable cost.
>
> The plans are, with practically no exceptions, incomplete, and prepared in such a way as to give the company submitting them special advantages over all the other bidders and delusive to the commissioners. Blank contract forms are furnished by the bridge companies and state that the work is to be done according to the attached specifications, but the specifications referred to are seldom, if ever, attached. The blank contracts, signed by the boards and bridge companies, often do not even state that the work will be done in a good, workmanlike manner. The proportions of cement, sand and stone in concrete work are not often given, and it is a rare case when there are any specifications whatever as to the quality of the cement, sand and stone to be used.

Obviously a simple remedy for the evil would be the employment of an engineer by every highway board contemplating the erection of a bridge, but the forces of ignorance and corruption that permit of the deplorable practices are just the ones which would oppose the entrance of an engineer into the "trade" between the community and the contractor. To the honest local commissioner, with his usual ignorance of things technical, the engineer is an aristocratic theorist whose coöperation would only add a costly hindrance to the hard-headed practical bridge builder. Add to this ignorance the influence of local politics and the occasional satisfaction of the greased palm and the independent engineer becomes practically non-existent in the design of small highway bridges.

There remains, then, but one remedy for the evil—supervision by state authority of all highway bridge construction. The solution is the same today as it was 20 years ago when it was first proposed, but the old arguments against it are not so strong. Today we are not so afraid of paternalism in the state, and though political supervision of purely technical affairs is to be deplored, we are more disposed to trust the independence of the engineer in office than was the generation before us. A state highway department properly manned and with the authority to compel the proper design of every highway bridge built within the borders of the state would protect the community against the venality and the ignorance of its elected representatives.

The constitution and scope of such a state body are matters deserving most careful study. It goes without saying that these state bridge engineers should be competent, unprejudiced and honest. These are the elementary qualities necessary to any government body; if we cannot get them, all government must be a failure. Quite as important is it that state supervision should not kill honest private competition. It is on this ground that the present opposition to a state bridge department is almost entirely based. Uptodate contractors realize that it is unavailing at the present day to offer political influence or official ignorance and corruption as arguments against the establishment of state control. The whole force of the opposition, both honest and dishonest, is brought to bear against this arrogance of power, this assumption of sole knowledge and dictation of design which the government engineer is said to be apt to develop. A short time ago a prominent bridge contractor wrote to us as follows:

> A competent designing engineer has nothing to fear from a competent expert acting in a supervisory capacity; but when State Engineers endeavor to promote their own ends by actually eliminating the competition of designing engineers, then we feel that we have grounds for complaint. The State Engineers of Iowa, Illinois, Virginia and Massachusetts supply the detailed designs for bridges and repulse every attempt on the part of the designing engineer to compete.

Even bearing in mind that this is the complaint of a contractor who has probably been forced out of a job, it has a basis of truth. The State Engineer should not undertake work as a designer except on purely state work built with state funds. His duty should be to guard the interests of the various communities in

matters of safety and economy. The opportunities for design should be free and open; but the design finally adopted should be safe and within the range of permissible cost.

Even with the added safeguard of state supervision, the criminal activities of the bridge pool cannot be always checkmated, as the following extract from the 1909-10 report of C. W. Comstock, State Engineer of Colorado, shows:

It has been the policy of this office to design in detail all of the bridges to be constructed under state appropriation, whether of steel, wood, concrete or other material. It has been extremely difficult to get reasonable bids in many instances. For years there has existed a recognized pool among highway bridge contractors who divide the state into districts and allot one district to each contractor. Although there is a semblance of competitive bidding whenever a bridge is advertised, the low bidder in each such competition (?) is known in advance to the members of the pool and the others place their bids above his figure. This in itself would not do so much damage if it were not for the practice of "loading the bid" with a certain amount over and above the price which the contractor is to receive, this additional amount being distributed among the other bidders. The amount of which the state or the county is robbed by this practice in any specific case is difficult to ascertain, but a little light is thrown on the subject by the following facts:

In one instance, by a series of fortuitous happenings, a bridge contract was awarded to a contractor not in the pool, after all bids received in response to a previous advertisement had been rejected. The savings on this contract was nearly $6000, and this was nearly 50% of the price which had finally to be paid for the work. Had the contract been given to the member of the pool who was low bidder at the first competition, practically one-third of the money paid to him would have been in excess of the cost of the work plus the legitimate profit.

In July, 1909, the State Engineer, well aware of the existence of this pool and of its method of operation, endeavored to evade it by awarding a general contract for all the structural-steel work to be built by the state during this biennial period at specified prices per pound for the finished work delivered at Colorado common points. Specifications and a contract on this basis were prepared and advertisements for bids inserted in a number of engineering periodicals throughout the United States. A bona fide bid from a responsible firm, accompanied by a check for $2000 as a guarantee of good faith, was received, naming the following prices:

	Cents per lb.
Riveted steel trusses	3.75
Rolled steel floor beams and joists	3.00
Steel lattice railings	5.00
Tubular piers and bracing	3.40

As an illustration of the saving which could have been made by this contract, the cost of one of the bridges now under construction in Garfield County under this proposed contract, as compared with its cost under the contract which was actually executed, may be shown. The steel in one of these bridges weighs 181,340 lb. Of this 18,240 lb. is in the steel floor beams, which would have been delivered under the proposed contract at Colorado common points for 3c. per lb. The remainder of the work would have cost 3.75c. per lb., making the total $6663.45. To this must be added the additional freight from common points to points on the western slope at $12 per ton. This amounts to $1088.04. The cost of erection would probably not exceed $15 per ton, but if taken at $20 per ton would amount to $1813.40. The total cost of the steel work erected would have been $9564.89. The wooden floor, at $35 per 1000 ft. board measure, would cost $1050. The masonry substructure would cost not to exceed $5000, basing this on separate contracts for masonry which have been awarded by this office. The total cost of the completed bridge would then be $15,614.89. The actual price named in the contract which was executed for the construction of this bridge is $24,000, a little more than 50% more than the bridge would have cost under the proposed contract.

The State Engineer was prepared to accept this bid and execute a contract at these prices. However, when the proposed contract was submitted to the Attorney General, he, in consultation with the attorneys for the bidder, decided that the contract could not properly be executed under the terms of the appropriation bills. This move, therefore, had to be abandoned.

Occasionally such practices can be brought to the attention of a grand jury and punished, but generally the guilty parties are shrewd enough to steer clear of such dangers. It is the plain duty of the legislatures of the states to arm their engineer officials with some protective method, such a one as that attempted by Mr. Comstock or possibly the well known provision of the New York State Barge Canal that no accepted bid shall be more than 10% greater than the engineer's estimate. This latter presupposes a competent and honest State Engineer, but, as we have before remarked, the whole system of government breaks down unless reasonable competence and honesty of the public officials can be assured.

Special Check Valves on City and Factory Water Supply Interconnections, Auburn, N. Y.

By J. Walter Ackerman*

Special check valves, designed to prevent the pollution of the city water supply of Auburn, N. Y., at times when special factory supplies are supplemented from the city mains, have been installed within the past few years. The conditions which led to their installation, as well as the valves themselves, are described in this article.

Auburn is a manufacturing town, situated in the central part of the state, having a population of about 34,000. The water supply is pumped directly into the distribution system from Owasco Lake, one of the finger lakes of central New York, containing a surface area of about 10 sq.miles, and a drainage area of about 200 sq.miles of normally rural population, with a few small villages on one of the main tributary streams, each of the villages discharging some pollution.

*Superintendent of Water Works, Auburn, N. Y.

Early in the year 1908 a small typhoid outbreak occurred in the city. Competent investigators were employed to trace the source. All of the evidence collected seemed to point to the city water supply as the cause of the outbreak. [As may be inferred from what follows, if the water supply was to blame it was not the water supply proper, but instead polluted auxiliary mill supplies, which gained access to the city mains through defective check valves.—Ed.]

The writer assumed charge of the municipal water-works in September of the same year (1908), and upon carrying out investigations with regard to some of the factory supplies learned incident-

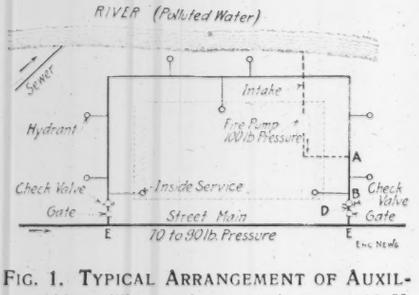

Fig. 1. Typical Arrangement of Auxiliary Mill Water Supply, Auburn, N. Y.

ally that at the fire tests conducted daily, and also at irregular times, as required by the Underwriters, the employees made haste to draw water for drinking purposes immediately upon the signal for the same, in order that they might not get bad and foul-testing and smelling water. While this instance did not disclose any gross negligence on the part of this particular factory, it was the cause of an investigation being made of the entire auxiliary fire equipment of the different mills and factories of the city. All of the check valves in the fire services for the purpose of preventing the back flow from the underwriters' pump were examined and tested. These were located and buried under the ground, the same as any other water-pipe appliance, like gates, hydrant connections, etc., and consequently had never received any attention. Almost without exception they were leaking badly at times. This resulted in a sweeping order by the water commissioners to disconnect all fire services that were so installed that polluted water from the underwriters' pump might be forced back into the mains. As this so vitally affected the insurance, the manufacturers called the Factory Mutual people, of Boston, in conference. The

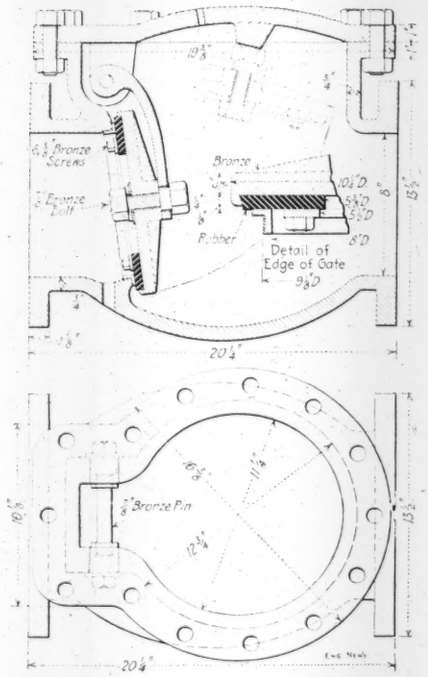

FIG. 2. SPECIAL 8-IN. HORIZONTAL CHECK VALVE ON AUXILIARY FIRE PROTECTION WATER SUPPLY FOR MILLS, AUBURN, N. Y.

(Ludlow Valve Mfg. Co., Troy, N. Y.)

latter first suggested the installation of two double checks, instead of one. This was also found to be unsatisfactory after numerous tests and examinations, as the check valves themselves seemed to be faulty in design. This condition was called to the attention of the owners and the Mutual insurance interests, and it finally resulted in the new design of check valve.

The principal features of this valve are that all moving parts—the clapper, the seat ring—were made of bronze. The interior of the cast-iron check valve was coated with an asphaltic-base paint, to prevent tuberculation. Additional clearance was given between the clapper and the body of the valve, and between the hinge of the valve and the body, for in some cases of examination we found that tuberculation had collected to such an extent that the valve was wedged wide open and remained in that position.

One of the specially designed check valves, made by the Ludlow Valve Manufacturing Co., Troy, N. Y., which represents to my mind one of the most advanced stages of design, is shown by Fig. 2. It has been further improved, so that the bolt holes holding the bonnet are slotted, thus enabling it to be removed by simply loosening the bolts. Then, without any further taking apart, the clapper can be turned up completely out of the case, and the seat ring, the rubber disk and all parts of the same, can be readily examined. Some of the other types which we have installed do not have these features, so that in order to examine the seat ring, the bronze pin on which the clapper revolves has to be removed and the clapper taken out.

Our final installation consists of double check valves of this new and approved design, placed in brick or concrete accessible vaults, with appliances for testing by means of pressure gages and drips so located as to test whether there is any leakage. Every six months the bonnet is removed from the valve and the interior carefully inspected to see that there are no further errors of design to be corrected. It has been a long series of trials, some of the installations being made the third time before they became thoroughly satisfactory to both the water commissioners and the Factory Mutual Insurance people.

Our typical form of factory and mill fire connections is shown by the diagram, Fig. 1. The arrangement of double check valves is shown by Fig. 3. This is the design of the Associated Factory Mutual Fire Insurance Co., approved by the Water Board. It represents practically the way in which our fire services are now connected, except that (1) the mill supply does not always have the meter in the same pit with the check valves; and (2) in a number of cases, on some large installations where it is necessary for mills to have two connections from 8 to 12 in. in size, that in place of the separate meter feeding back of the check valves, in the position where the T (Fig. 3) is placed, to feed the service meter, a Hersey factory meter is attached, and then the large yards take all of the supply, both mill and fire, through the factory meter. However, the mill supply generally is tapped between the Hersey factory meter and the check valves, in order that polluted water may not reach the mill operatives, on account of the check valves in the pit preventing it. The Hersey factory meter, on account of its check valves, gives an added protection against polluted water going back into the city mains.

Some of the manufacturers have shown a great deal of ingenuity in developing the new types of check valves, both for ease of examination, accuracy of design and theoretical hydraulics. There are, I believe, but a very few cities in the United States that are equipped like the Auburn water-works.

The Cleveland Civic Center, or unified group of public buildings, is progressing. The federal and the county buildings are completed and occupied, the city building is under construction, and in the latter part of May, 1912, bonds for the library building were voted.

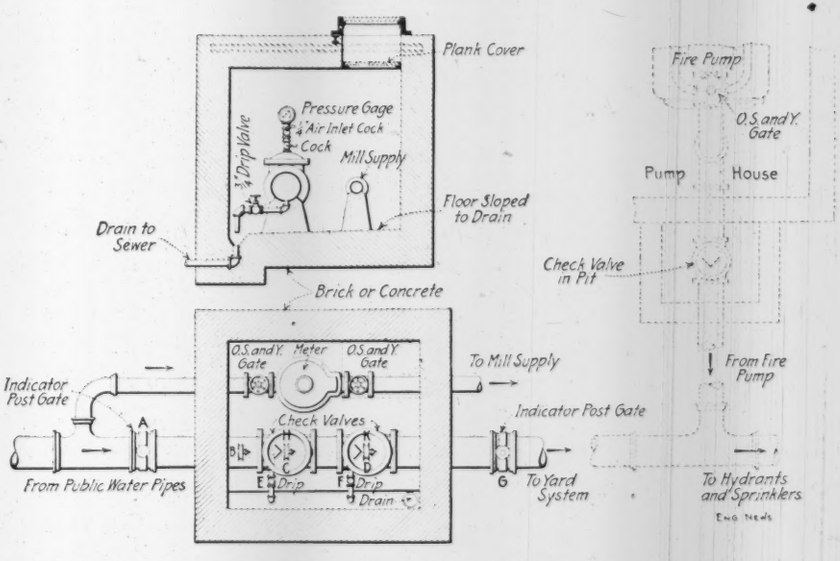

FIG. 3. ARRANGEMENT OF TWO CHECK VALVES ON AUXILIARY WATER SUPPLY, AUBURN, N. Y.

(Inspection Department, Associated Factory Mutual Fire Insurance Co., Boston, Mass. Dated August, 1909; revised to May 1, 1910.)

The specifications under which these special check valves are made require the seat ring, disk, holding ring and screws, disk stud, arm, hinge pin and bushings to be of bronze, disk to be faced with medium hard rubber and liberal clearances left around clapper and arm in all positions.

NORMAL CONDITION OF VALVES—Open, ind. post gates, A-G; shut, cocks, B-C-D, drip valves, E-F.

Once in six months inspect check valves and thoroughly clean whole interior, removing disks if necessary.

To facilitate removing check valve covers, pack with manilla paper and machine oil.

METHOD OF TESTING—Close gate A and open drip E and air cock B. If pressure holds at gage C but flow continues at E, gate A or check valve H leaks. To determine which is leaking, open drip F, and if gage C falls to zero and if flow from E does not decrease, gate A is leaking and valve H is tight. Open air cock C, and if flow from F ceases, valve K is tight.

For testing under higher pressures, close gate at G and use a hand force pump attached at F to test tightness of H. Open G and start fire pump to test K.

Caution—Immediately at close of test see that gates A and G are open.

Cattle Wrecked a Highway Bridge in Jefferson Township, Iowa, May 29. The bridge was a steel structure, 60 ft. long, spanning the Marquoketa River. Reports state that the cattle were huddled closely together and that the combined weight of the 54 head on the bridge was about 60,000 lb. Only eight of the animals were killed.

A Fire in Chilcoot Tunnel, through Beckwith Pass, 10 miles east of Portola, Calif., on the Western Pacific Ry., had already destroyed the timbering of the tunnel for a distance of 450 ft. from the east mouth, according to press reports of May 31. The destruction of the timber work has caused the cave-in of a large amount of earth and it is estimated that the tunnel cannot be opened to traffic again within six months.

An emergency track is to be built over the pass, to be used by through trains pending the reopening of the tunnel. In the meantime passengers and baggage are being transferred around the pass in automobiles. Reports state that a workman was killed by smoke or gas, June 1, while attempting to get a bucket of drinking water from a spring in the long open cut at the east end of the tunnel.

An Ammunition Factory Explosion, June 7, in the vicinity of Vienna, Austria, caused the death of 30 persons. According to press reports, about 200 tons of powder exploded.

An Eruption of Mount Katmai in the Aleutian Range near the base of the Alaska Peninsula began June 6. Reports state that fishing towns on Kodiak Island, about 35 miles distant across Shelikof Strait, are endangered by the eruption. The mail steamer "Dora" was overtaken by a shower of volcanic ash while passing through the strait, and reports state that her decks were covered to a depth of 3 in. The earth tremor accompanying the volcanic eruption was detected by the seismograph of the University of Washington, at Seattle, some 1500 miles distant. Katmai volcano has been dormant for a number of years. The present volcanic disturbance is claimed to be the most violent ever recorded in Alaska.

A French Submarine Was Sunk June 8 during Naval maneuvers in the Race of Alderney, between Aurigny Island and Cape Hague, off the coast of France. Reports state that the submarine torpedo boat "Vendemiaire" rose from below the surface directly in the path of the battleship "St. Louis." The crew of 23 men were drowned. The "Vendemiaire" was 167 ft. long with a beam of 16 ft. This is the sixth submarine to be lost by the French Navy. The "Pluviose," of the same type as this latest wreck, was run down by a channel steamer May 26, 1910. Reports state that while the "Vendemiaire" is lying in only about 25 fathoms of water, it is doubtful if the vessel can be recovered, since a buoy left to mark the place of the collision was carried away by the swift current.

An Aeroplane Acceptance Test at the U. S. Army Aviation School at College Park, Md., June 11, resulted fatally to the professional aviator operating the machine and his passenger, Lieut. L. W. Hazelhurst, Jr., of the 17th infantry. The aëroplane, a Wright biplane, had already completed eight of the ten different tests required before acceptance. The ninth test was to be a spiral climb to a height of 2000 ft. with a load of 450 lb. in addition to fuel, water and oil. The weight of the two men was supplemented by 125 lb. of ballast to complete this load. The test was begun successfully and on the first circuit of the field the machine had attained a height of some 30 ft. In making the turn at the end of the field, according to press reports, the aëroplane pitched forward and plunged straight to the ground. Reports state that the bodies of the men were found several feet from the machine. Both were killed instantly.

A great number of aëroplane fatalities have occurred during the past six months which have not been noted in these columns. Many of these were plainly the result of reckless daring or lack of skill on the part of the aviators, and hence of little meaning in the development of safety in flight. This latest accident, however, occurred during a serious test of the machine's performance, and with an aviator in charge who must have been chosen for his skill and reliability.

The Building of the S.S. "Aquitania," of the Cunard line, has been carried on with strict secrecy so far as concerns her dimensions or any detailed information on features of construction. In the May 31 issue of "The Engineer" (London), however, are published a number of good photographs showing progress in the construction of the vessel from March, 1911, when the first keel plates were laid, up to Mar. 22, 1912. The latest photos show the bottom plating completed and the side frames apparently all in place. It is reported that this vessel will be somewhat larger than the "Imperator," of the Hamburg-American line (see Eng. News, May 30, 1912). This means she will be in the neighborhood of 900 ft. long. She will be driven entirely by Parsons turbines driving four shafts, with the wing propellers 86 ft. forward of the after pair.

More Lifeboats Are Being Installed on steamships plying along the coast and on the Great Lakes as well as on transatlantic vessels as a result of the agitation created by the wreck of the "Titanic." The Erie & Western Transportation Co.'s Anchor Line, which operates a number of passenger vessels on the Great Lakes, has announced that all these ships will be equipped with enough lifeboats and rafts to accommodate all the passengers and crew. Wireless equipment of 150 miles radius has also been installed on these boats. A movement in the same direction is evident among the steamship lines whose vessels pass along Long Island Sound and the New England Coast.

Panama Canal Excavation during May totalled 2,506,916 cu.yd., a daily average of 96,420 cu.yd. for the 26 working days. Rainfall for the month was 9.01 in. The amount of concrete laid in May was 112,497 cu.yd., and 474,752 cu.yd. of fill was placed in dams.

A Transatlantic Wireless Telegraph station, it is reported, will be erected by the Marconi company on a site recently purchased, near Belmar, N. J. About 550 acres were bought in order to get a properly oriented location, 6000x1500 ft. It is expected that as many as 12 or 14 towers will be erected at a cost of $500,000. It is proposed to exchange messages between this station and one to be erected by the British company, near London; the proposed plan permits shorter land lines to these metropolitan centers and a reduction of time for the transmission of messages.

A Humphrey Direct-Acting Pump of 1050 gal. per min. capacity has been installed at the pumping station of the London Hydraulic Power Co., at Wapping, England, for the purpose of experiment and demonstration. The pump is of the four-cycle type with a 21-in. barrel and a 15-in. diameter play pipe. The lift is 25 ft. It works at a speed of about 13 cycles per minute. The installation was made by the Hydraulic Engineering Co., Palace Chambers, Westminster.—"Engineering."

A Large Diesel-Engine Ship, the "Jutlandia," the first to be built in Great Britain, had her official trials last month. The ship is an exact duplicate of the "Selandia," built in Denmark for the same shipping firm, whose successful trial trips made a sensation among English marine engineers a few months ago. According to a report on the "Jutlandia's" trials, given in "The Engineer," of May 24, the mean indicated horsepower of the engines for eight hours was 2740 hp., at 138½ r.p.m. This gives the boat a speed of 12.53 knots when light; the speed when with full cargo is expected to be 10½ knots. The fuel consumption was stated to be 0.333 lb. of Scotch shale oil per indicated horsepower-hour. The "Engineer" assumes that if the mechanical efficiency was the same as that claimed for the "Selandia," then the brake horsepower consumption was 0.387 lb. The mean effective pressure in the cylinders was 100.25 lb. per sq.in., the average of a set of cards taken on each cylinder of one engine set. The adjustment of the engines was so perfect, according to the cards, that the maximum compression pressure was very little exceeded during the combustion inside the cylinder.

Personals

Col. George W. Goethals, M. Am. Soc. C. E., Chief Engineer of the Panama Canal, was granted the degree of Doctor of Science by Columbia University on June 6.

Mr. J. R. Stephens, Assistant Chief Engineer of the Missouri Pacific Ry. system, has been promoted to be Chief Engineer, succeeding Mr. E. F. Mitchell, resigned.

Mr. W. A. Webb, until recently General Manager of the Texas Central R.R., has been appointed Assistant to the President of the Missouri, Kansas & Texas Ry., at Dallas, Tex.

Mr. E. H. Barnes, M. Am. Soc. C. E., Chief Engineer of the Grand Rapids & Indiana Ry., has been appointed Assistant to the General Manager, in addition to his duties as Chief Engineer.

Mr. E. N. Sheffield, Assoc. M. Am. Soc. C. E., formerly Assistant Engineer with the Connecticut Co., New Haven, Conn., has opened an office in Trinidad, Colo., for the general practice of engineering.

Mr. Howland Bancroft, M. Am. Inst. M. E., Mining Geologist of the United States Geological Survey, has resigned to devote his time to private practice, with offices in the Symes Bldg., Denver, Colo.

Mr. Le Roy Kramer, formerly Assistant to the Vice-President in charge of operation of the Chicago, Rock Island & Pacific Ry., has been appointed Assistant to the President of the Pullman Co., Chicago, Ill.

Mr. John C. McMynn, for the past 16 years associated with Robert W. Hunt & Co., Testing Engineers, has now be-

come associated with the Allen Engineering Co., First National Bank Bldg., Chicago, Ill.

Mr. C. L. Carman, formerly Chief Engineer of the Riverside Portland Cement Co., of Riverside, Calif., has entered private practice as a consulting engineer, with offices in the Insurance Exchange Bldg., Chicago, Ill.

Mr. John B. Hammill, formerly Passenger Trainmaster of the Boston & Albany R.R., at Boston, Mass., has been promoted to be Superintendent of the Boston-Springfield division, succeeding the late Philip Morrison.

Mr. Samuel D. Warriner, M. Am. Inst. M. E., former General Manager of the Lehigh Valley Coal Co., Wilkes-Barre, Penn., has been elected President of the Lehigh Coal & Navigation Co., succeeding the late William A. Lathrop.

Messrs. John Fraser and Thomas Gray have formed a partnership under the firm name of Fraser & Gray, to carry on the engineering contracting business formerly conducted by Mr. Fraser, with offices at 30 Church St., New York City.

Mr. W. C. Hurst, formerly Superintendent of the Cincinnati, Hamilton & Dayton Ry., is now General Superintendent of the Chicago, Peoria & St. Louis Ry., with headquarters at Springfield, Ill., succeeding Mr. C. R. Wescott, resigned.

Mr. G. S. Leavenworth, M. Am. Soc. C. E., for the past eight years Chief Engineer of the Powers & Mansfield Co., Troy, N. Y., is now with the engineering department of W. N. Coler & Co., of New York City, with headquarters at High Point, N. C.

Mr. W. Rees Jeffreys, General Secretary of the International Road Congress, is visiting in the United States for the purpose of interesting American road builders in the first international road congress, which is to be held in London, England, next year.

Mr. A. B. Apperson, recently General Superintendent of the Castle Valley R.R. in Utah, and formerly Division Superintendent of the Denver & Rio Grande R.R., has been appointed General Superintendent of the latter railway, succeeding Mr. J. W. Mulhern, resigned.

Dr. Eugene A. Smith, M. Am. Inst. M. E., has retired as Professor of geology and Dean of the engineering faculty of the University of Alabama, to devote his whole time to his duties as State Geologist of Alabama. He has been connected with the university for 45 years.

Mr. W. S. Becker, Superintendent of the Norfolk & Western Ry. at Bluefield, W. Va., has been appointed General Superintendent of the Western general division, succeeding Mr. G. P. Johnson, resigned. For a number of years previous to 1891, Mr. Becker was with the Northern Pacific Ry. in Montana.

Mr. Charles H. Wright, M. Am. Soc. C. E., has resigned as Chief Engineer of the Brown Hoisting Machinery Co., Cleveland, Ohio, and is now engaged in special work for the company in the Southwest. Mr. W. K. Monroe, Manager of the Engineering Department, now fulfills the duties of Chief Engineer.

Mr. Hugh C. Mitchell, formerly with the United States Coast and Geodetic Survey, Washington, D. C., has been appointed Engineer in charge of the topographical survey of the city of Cincinnati, Ohio, about to be undertaken by the Division of Sewerage Investigations, Designs and Plans, of the Department of Public Service.

Mr. E. H. Raquet, Chief Chemist of the New York, New Haven & Hartford R.R., at New Haven, Conn., has been promoted to be Engineer of Tests, at Boston, Mass., of the New York, New Haven & Hartford, the Boston & Maine and the Central New England Rys., succeeding Mr. M. C. M. Hatch, resigned, as noted elsewhere in these columns.

Mr. H. T. Cory, M. Am. Soc. C. E., formerly General Manager and Chief Engineer of the California Development Co., and in charge of the irrigation system of the Imperial Valley in Southern California, has opened an office in the Nevada Bank Bldg., San Francisco, Calif., as a consulting engineer. Associated with him is Mr. C. L. Cory.

Mr. M. H. Peck, Assoc. M. Am. Soc. C. E., formerly Professor of Civil Engineering at the Pei Yang University, Tientsin, China, and Mr. James Armstrong, formerly Engineer with the Gunn-Thompson Co., of New York City and Salt Lake City, Utah, have opened an office in the Hearst Bldg., San Francisco, Calif., for the general practice of civil engineering.

Mr. Samuel G. Thomson, who has been Acting Superintendent of Motive Power of the Philadelphia & Reading R.R., has been appointed Superintendent of Motive Power and Rolling Equipment. Mr. Thomson graduated from Princeton University in 1898 and entered the railway service as a special apprentice at the Altoona shops of the Pennsylvania R.R.

Mr. Charles W. Comstock, M. Am. Socs. C. E. and M. E., who has been State Engineer of Colorado since 1909, has taken the position of Engineering Manager of the Goldsborough Co., with headquarters at the company's main office in the First National Bank Bldg., Denver, Colo. He will have the general direction of all the engineering departments of the company.

Mr. M. C. M. Hatch, recently Engineer of Tests of the New York, New Haven & Hartford R.R. and affiliated lines, at Boston, Mass., has been appointed Superintendent of Fuel Service of the Delaware, Lackawanna & Western R.R., with headquarters at Scranton, Penn. Mr. Hatch was formerly Chief Draftsman of the Boston & Maine R.R., and was appointed Engineer of Tests in December of last year.

Mr. Oscar Wenderoth, of the firm of Carrere & Hastings, Architects, New York City, has been selected by the Secretary of the Treasury to be Supervising Architect of the Treasury Department of the United States, succeeding Mr. James Knox Taylor, resigned. Mr. Wenderoth was connected with the Supervising Architect's office for a number of years before coming to New York. He was also connected with the construction of the Senate and House of Representatives office buildings in Washington, D. C.

Mr. Waldemar Lindgren, M. Am. Inst. M. E., Chief Geologist of the United States Geological Survey, has been appointed Professor and head of the department of geology at the Massachusetts Institute of Technology, succeeding Dr. T. A. Jaggar, who is to be Director of the Hawaiian Volcano Observatory. Prof. Lindgren received his degree of Mining Engineer at the School of Mines at Freiberg, in Germany, in 1883. He has been associated with the U. S. Geological Survey since 1884, and was appointed Chief Geologist in November of last year.

Messrs. Daniel Willard, President of the Baltimore & Ohio R.R., and C. R. Van Hise, President of the University of Wisconsin, are two of the members of the board of arbitration appointed to settle the differences between the locomotive enginemen and the railways as to wages. Other members of the board are: Messrs. Oscar Straus, former Secretary of Commerce and Labor; Albert Shaw, Editor of the "American Review of Reviews"; Otto Eidlitz, former Chairman of the Building Trades Employers' Association of New York; Frederick N. Judson, a lawyer, of St. Louis, Mo., and P. H. Morrissey, former President of the Brotherhood of Railroad Trainmen.

Mr. James J. Hill has resigned as Chairman of the Board of Directors of the Great Northern Ry., according to persistent newspaper reports, and is succeeded by his son, Mr. L. W. Hill, who recently resigned the presidency. Mr. Hill's retirement will mark the close of his official career in the active management of the various Hill lines, but does not mean that he is to relinquish entirely all active work in connection with this railway. Mr. Hill is now nearly 74 years old and has been a railway manager for 34 years. In 1878 he organized a company to take over from its Dutch owners the St. Paul & Pacific R.R. The following year he became its General Manager, and under his management this railway expanded into the Great Northern Ry. system, of which Mr. Hill was for many years President.

Mr. H. S. Morse, M. Am. Soc. C. E., has been appointed Engineer in charge of the Division of Sewerage Investigations, Designs and Plans, Department of Public Service, of the city of Cincinnati, Ohio. Mr. Morse is a graduate of the Massachusetts Institute of Technology, class of 1903, and for a number of years was with the United States Reclamation Service on the Lower Yellowstone Irrigation Project. Later he was Resident Engineer in charge of construction for the Sewerage Commissioners of Louisville, Ky. The city of Cincinnati is about to spend $125,000 on a comprehensive sewerage investigation. The work will include the making of a topographic map of the entire sewerage area, a survey of all existing sewers, the planning of relief sewers in the congested districts, new sewers in recently annexed territory, studies for the improvement of the channel in Mill Creek and plans for an intercepting sewer for taking all the sewage to a place of treatment and disposal. Mr. Henry U. Waite, City Engineer of Cincinnati, is Chief Engineer in general charge of all the city work.

Mr. Henry J. Horn, Vice-President of the New York, New Haven & Hartford R.R., will also become Vice-President of the Boston & Maine R.R., in charge of operation, on June 30, succeeding Mr. Frank Barr, who will retire after 44 years' service. Mr. Barr began his railway career as a clerk; he became Superintendent of the Worcester, Nashua & Portland division of the Boston & Maine in 1892, Assistant General Manager in 1896, and Vice-President in 1903.

Mr. Horn is a native of St. Paul, Minn., and graduated from the Massachusetts Institute of Technology in civil engineering in 1888. He soon after became an assistant engineer of the Chicago, St. Paul & Kansas City Ry. A year later he entered the service of the Northern Pacific Ry. as a draftsman. At the end of a year he became Chief Draftsman of the Middle district. In 1891 he returned

to field work as Resident Engineer, and served later for four years as Supervisor of Bridges and Buildings. He was appointed Division Superintendent in 1897, Assistant General Superintendent of the Middle district in 1902, and in 1904 General Manager of the Northern Pacific Ry.

Obituary

M. L. Sternberger, President of the Dayton, Lebanon & Cincinnati R.R. & Terminal Co., died at his home in Jackson, Ohio, on June 2, aged 51 years.

Robert Francis Cartwright, for a number of years associated with the Otis Elevator Co., of New York City, and later President of the H. & M. Valve Co., New York City, died at his home in that city on June 4. He was 66 years old

Eugene Pitou, Vice-President of the National Meter Co., New York City, died at his home in New York, on June 5, from apoplexy. He was 72 years old and had been associated with this company for many years. For a time he was associated with the Crescent and Standard Oil companies.

Matthew Dow, a prominent contractor on the Pacific coast, died recently at Prince Rupert, B. C. Mr. Dow was the head of the contracting company which obtained the preliminary work on the new dry dock and ship-building plant to be erected by the Grand Trunk Pacific Ry., at Prince Rupert. Mr. Dow was contractor for much construction work on the West coast. He built the Grand Trunk Pacific docks, at Vancouver and Victoria, B. C., and Seattle, Wash.

James K. Geddes, M. Am. Soc. C. E., General Manager and Chief Engineer of the Ohio River & Western Ry., died at his home in Zanesville, Ohio, from blood poisoning, on June 6. He was born on Sept. 7, 1856. In 1881 he began railway work as a leveler on the location surveys of the Texas & St. Louis Ry. For ten years he was engaged in railway construction in the Southwest as Assistant, Resident and Chief Engineer of various lines. In 1891 he was appointed General Manager and Chief Engineer of the Bellaire, Zanesville & Cincinnati Ry., and two years later was Receiver and General Manager of the same railway. After eight years in the receiver's hands the road was reorganized as the Ohio River & Western Ry., of which Mr. Geddes was also appointed General Manager and Chief Engineer.

James Stephenson, former General Superintendent of the Grand Trunk Ry., of Canada, died on June 5, in Clevedon, England, where he had made his home since retiring from active railway work about 12 years ago. He was born in Lancaster, England, in 1837. At 18 years of age he emigrated to Canada, and began his career in the employ of the British American Telegraph Co. He entered the service of the Grand Trunk Ry. in 1856, and remained with the company continuously to 1900. He rose from the position of telegraph operator through various grades in the operating and passenger departments to the position of General Passenger Agent in 1881, General Superintendent of the Toronto and Montreal divisions in 1884, and in 1892, General Superintendent of all the Grand Trunk Ry. system. He leaves a widow, who is a sister of Mr. William Wainwright, Vice-President of the Grand Trunk Pacific Ry.

James B. Hogg, M. Am. Soc. C. E., Consulting Engineer, of Connellsville, Penn., died on June 4, following a long illness, which had confined him to his home for many weeks. Mr. Hogg was born in Prittstown, Penn., 55 years ago. He graduated from Lafayette College in 1881 and began engineering work as an instrumentman on the location surveys for the Pittsburgh, McKeesport & Youghiogheny R.R. In 1886 he went to Seattle, Wash., and for a while was with the engineering staff of the Northern Pacific Ry. Later he was associated with the City Engineer of Seattle, and for two years was Assistant City Engineer. He was Chief Engineer of the Port Townsend Southern Ry., and had charge of its location and construction. Mr. Hogg also served some time as Assistant Engineer of the Oregon Railroad & Navigation Co. He returned to the East in 1900 and was engaged by the Carnegie Steel Co. and the H. C. Frick Coke Co. in extensive railway and other surveys. Completing this work he established an office in Connellsville for the general practice of engineering, and had carried on a wide and varied practice with branch offices in Uniontown, Brownsville, Scottdale and Pittsburgh. He was serving, at the time of his death, a third term as County Surveyor and had been Borough Engineer of Connellsville for several years. Mr. Hogg was married in 1903 to Miss May Reid, of Connellsville, who survives him.

Engineering Societies

COMING MEETINGS

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 17-19. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

CANADIAN ELECTRICAL ASSOCIATION.
June 19-21. Annual meeting at Ottawa, Ont. Secy., T. S. Young, 220 King St., West, Toronto, Ont.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 25-28. Annual convention at Boston, Mass. Secy., F. L. Hutchison, 33 West 39th St., New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 25-28. Annual convention at Seattle, Wash. Secy., C. W. Hunt, 220 West 57th St., New York.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 26-28. Annual meeting at Boston, Mass. Secy., H. H. Norris, Cornell University, Ithaca, N. Y.

SOCIETY OF AUTOMOBILE ENGINEERS.
June 27-29. Summer meeting at Detroit, Mich. Secy., C. F. Clarkson, 1451 Broadway, New York.

NATIONAL MUNICIPAL LEAGUE.
July 8-12. Annual meeting at Los Angeles, Calif. Secy., C. R. Woodruff, North American Bldg., Philadelphia, Penn.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 11-12. Summer meeting at Detroit, Mich. Secy., W. W. Macon, 29 West 39th St., New York.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 16-19. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

International Railway Fuel Association—In the report of the annual meeting, in an issue of June 6, D. B. Sebastian was named as Secretary and Treasurer, which positions he has held in former years. This statement was erroneous, as Mr. Sebastian was elected Second Vice-President. The new Secretary, appointed by the Executive Committee, is C. G. Hall, Fuel Agent, Chicago & Eastern Illinois R.R., Chicago.

American Society of Heating and Ventilating Engineers—The headquarters for the convention in Detroit, July 11-12, will be at the Hotel Tuller.

Mining and Metallurgical Society of America—The committee appointed to frame regulations for the award of a gold medal by this society has submitted a report recommending that the medal be awarded each year for different kinds of service to the profession and the community. The following list was suggested by the committee as a basis for the award in different years: 1. For services contributing to better protection of mine workers. 2. For work tending to safeguard the interests of mine investors. 3. For distinguished work in the field of economic geology. 4. For notable contributions to the science of coal mining. 5. For notable contributions to the science of metal mining. 6. For notable contributions to the science of ferrous metallurgy. 7. For notable contributions to the science of nonferrous metallurgy.

International Electrical Congress—The personnel of the executive committee of the committee on organization of this congress, which is to be held in San Francisco in connection with the exposition in 1915, is as follows: Charles P. Steinmetz (President), Arthur E. Kennelly, C. O. Mailloux, W. D. Weaver, Henry A. Lardner, Edward B. Rosa (Secretary), Preston S. Millar. This congress is made up of 34 electrical societies, including the American Electric Railway Association, American Electrochemical Society, Association of Edison Illuminating Companies, Association of Railway Electrical Engineers, Association of Iron and Steel Electrical Engineers, Illuminating Engineering Society, International Association of Municipal Electricians, National Bureau of Standards, National Electric Light Association, Franklin Institute, Society for the Promotion of Engineering Education, Western Society of Engineers, and a number of State electrical associations, all of which are represented on the organizing committee. The organization of the congress is under the direction of the American Institute of Electrical Engineers.

International Tramways Union—At the meeting to be held in Christiania, Norway, July 2-5, the following subjects will be presented for discussion: (1) Influence of new transportation facilities on the development and extension of large cities; G. L. Dausset, Paris, France. (2) Street railway and residence accommodations in large cities; M. Kuhles, Munich, Germany. (3) Motor cars on railways, especially on lines of light traffic; Z. E. von Teschenbruck, Vienna, Austria. (4) Handling crowds on tramways in large cities; M. Hradetzky, Vienna, Austria. (5) Electric traction; L. Bacqueyrisse, Paris, France, and M. Eisig, Chemnitz, Germany. (6) The German regulations as to electrolysis as affecting street railways; M. Buschbaum, Berlin. (7) Maintenance of overhead equipment and feeders; E. d'Hoop, Brussels, and M. Otto, Berlin. (8) Location and organization of car sheds; J. H. Neiszen, Amsterdam. (9) Rail corrugation, A. Busse, Berlin. (10) Removal of snow from street railway tracks; T. Poppe, Christiania, Norway. (11) Relations of local and interurban lines with main lines in regard to through traffic, M. Campiglio, Milan, Italy. (12) Accounting systems for light railways; G. Lembourg, Brussels. (13) The heating and lighting of cars on local and light railways; F. de le Hoye, Brussels.

Engineering Literature

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CORRESPONDENCE

An Explanation of Standard Forms of Level Notes

Sir—I notice in your issue for May 16 the review of my book "Standard Forms of Field Notes for Civil Engineers." I wish to call your attention to the following criticism:

> It is not so complete as might be wished for, and many things which the author chooses to call standard might be questioned; as, for example, Plate E, which shows a sample page of level notes with the stationing from bottom to top of page.

An inspection of Plate E will show the notes running from the top of the page to the bottom. The stationing is shown running from the bottom of the page to the top for the reason that the levels were taken running against the chainage, instead of running with the chainage along the track. This often happens in practice for this reason: Suppose the engineer should chain five or ten miles along the track and the level happened to be at the end of the completed chainage. It would be convenient to start the leveling at the point where the level happened to be and thus save walking back to the beginning of the chainage in order to start at the 0.00 station.

I believe that it is the best practice to always run the level notes down the page, but I do not believe that it makes any difference whether you run with your chainage or against it.

CHAS. C. ANTHONY.

Schenectady, N. Y., May 23, 1912.

REVIEWS

A Contribution to Hydraulics

Reviewed by GARDNER S. WILLIAMS

A B C OF HYDRODYNAMICS—By Lieut.-Col. R. DeVillamil, R. Eng. (Ret.) London: E. & F. N. Spon, Ltd., 57 Haymarket. New York: Spon & Chamberlain. Cloth; 5½x8¾ in.; pp. 135; 48 text illustrations. $2.50, net.

If this little book, which is rather an essay than a textbook, had been intelligently read by the several writers of our modern works on Hydraulics, and by recent experimenters in the domain of that subject, the productions of the former would have been greatly improved, and results of the latter immensely more valuable. The author has succeeded in bringing within the ken of the ordinary American student, in some part at least, the usually considered abstruse reasonings of the great physicists, Newton, Kelvin, Rayleigh and Helmholz; and this without recourse to an undue amount of mathematics, so that those who are unfortunately rusty in the calculus need not hesitate to read the book, as it includes nothing more dangerous than a few simple algebraic expressions. The author has made a careful study of portions of the work of Du Buat that are usually overlooked, and from them is able to establish theories of the flow of water that are seldom presented except as suggestions.

The introduction to the book is unfortunately occupied with pointing out some inconsistencies in the works of commonly accepted authorities. Unfortunately, not because error should not be exposed, but because its presentation at that place in the book has the effect of masking for a time the really admirable work of the later chapters, as the reader is continually expecting a controversial tone which he is unconsciously disappointed in not finding, until his interest becomes absorbed in the real argument and he forgets the previous impression. Had the matter in the first chapter been introduced, from time to time, with the author's analysis of the particular questions considered, the result would have been more satisfying.

The conclusions of the several chapters are summarized at the end of each, substantially as follows:

I—The subject of liquid resistance is confused, due to the mathematically assumed perfect liquid, frictionless and without a free surface, being compared to an ordinary liquid with a free surface.

II—All the forces which act upon a fluid at rest are such that if the liquid be inclosed in a fixed envelope, they cannot disturb its equilibrium, but they may exercise a most important influence upon a liquid in an open vessel.

III—A liquid must flow and can only flow from a region of higher to one of lower pressure, and does not ordinarily obey Newton's second law. As the velocity of a liquid increases its pressure decreases, and this change can only be accomplished by the conversion of potential to kinetic energy, which latter cannot be conveyed directly to a liquid but must be transmitted through the potential state.

IV—The resistance of a body moving in a perfect liquid would vary as the density of the liquid and as the square of the body's velocity, and would continually diminish with the depth of immersion until it vanished at a certain finite depth. If the edges of the body be mathematically sharp the resistance vanishes only at an infinite depth.

V—Fluid friction is caused by a stress set up in a liquid to resist shearing, and increases as the velocity only. At a critical speed the liquid breaks into eddies. The resistance may be expressed by $R = AV + BV^2$, where AV is the resistance due to viscosity, and BV^2 that due to eddies. Viscosity is not in general the cause of eddies, but tends to reduce them.

VI—A viscous fluid when flowing "by obligation" does so in a manner similar to that of the perfect fluid of the mathematicians; a flow "by obligation" being

*Civil and Consulting Engineer, Ann Arbor, Mich.

such an one as occurs between parallel plates very close together. The form of flow imagined by Helmholz and Kirchoff, and called the "potential cleavage flow," is not possible except under very rare conditions, because of its instability.

VII—Water flowing to meet a body, behaves like the mathematicians' perfect fluid, subject to some slight variations caused by viscosity, and the average pressure on the anterior, upstream, side of the body is less than the hydrostatic pressure, being equal to it at the center of a circular flat plate and decreasing toward the edges.

VIII—The resistance of a long flat board drawn edgewise through the water may be expressed by $R = AV + BV^2$, where A and B are constants for each flat plane. If for A we substitute aL, a is then a constant for all planes and AV, the resistance due to viscosity, varies as the velocity and the shearing area. The coefficient B of the inertia resistance (or dynamic resistance) varies in a manner difficult to explain, probably dependent on the vibration of the board transversely to the line of motion.

IX—The resistance of a body in a liquid depends in part on how much the body is wetted by the liquid.

X—For the formation of sinuous motion a cross pressure is necessary.

XI—Liquids flowing in tubes are subject to the same law, $R = AV + BV^2$. If the tubes are very small the second term does not appear. Some salts added to water cause it to flow more freely, others less so. Vortices are created when a circular disk moves through water.

XII—Vortex rings are formed by the variable movement of a fluid past a sharp or moderately sharp edge, and for every smoke ring emitted from a smoke box there is a clear air ring formed in the box. Vortices in water or air are coreless and cannot be cut.

XIII—The resistance to bodies moving in liquids is chiefly due to the formation of vortices behind them, and there are no special laws applicable to flat bodies that do not equally apply to round or fish-shaped bodies.

The appendix deals with the application to Aëronautics and shows that on account of the compression of the fluid $R = AV + BV^2 + CV^3$.

The general argument is substantially along the following line:

The first essential proposition considered is that in an unlimited fluid, or one without a free surface, conditions exist that are greatly changed when a free surface exists, and laws applying in the first case fail entirely in the second, and that the conditions of the second merge into those of the first as the free surface becomes more and more remote. It then follows that a liquid flowing in a closed pipe approaches more nearly to the unlimited case than does the same liquid in an open channel, and the less compressible the liquid the more nearly does the former approach the theoretical condition. Hence it may be shown that the resistance to motion of a floating object in a closed pipe is less than in an open channel, and that the resistance in the latter case decreases as the depth of immersion increases.

Following this reasoning out the author later shows that there must be limits, depending upon the pressure, to the velocity at which the resistance to flow will increase as the square. The lower limit has, of course, been commonly known since the researches of Osborne Reynolds, but the existence of an upper limit or *critical velocity* has not hitherto been commonly appreciated.

The author then takes up the resistance to motion of a liquid in its channel, and demonstrates theoretically, the correctness of the long accepted equations of Du Buat, Prony, and others, expressing the resistance as a function of the first power and the square of the velocity. In this equation it is supposed that the frictional resistance varies as the first power, and resistances due to impacts or inertia vary as the second power, and that therefore no single exponent of the velocity can correctly represent the law.

While agreeing with the author's deductions from his premises, and recognizing the force of the arguments and experiments cited, the reviewer would call attention to a series of investigations, undertaken at his suggestion and carried out under his observation several years ago, that it was hoped would settle this question by direct experiment. The results of this investigation, made in the Hydraulic Laboratory of the College of Civil Engineering of Cornell University, by Messrs. A. V. Saph and E. W. Schoder, were published in the *Transactions* of the American Society of Civil Engineers, Vol. LI, for 1903. They consisted of observations on the loss of head in fifteen seamless drawn-brass tubes of diameters ranging from 2.0504 to 0.09636 in., and on five galvanized-iron pipes of diameters ranging from 1.042 to 0.350 in., and also upon rubber hose of diameters ranging from 0.519 to 0.254 in. No similar investigations of either ancient or modern times have been conducted with greater care, and nearly eight hundred experiments were recorded.

If the frictional resistances be mainly due to the rubbing of the water on the pipe wall, and the author's hypothesis be correct, they would seemingly be proportional to the circumference, while the inertia resistances must depend upon the area of a section of the pipe. In a small pipe then the former would predominate and in a large pipe the latter, and hence were a single exponent of the velocity adopted, it would be less for the smaller than for the larger pipes. The investigations to which reference is made appear to show no distinction between the exponents for the small and the large pipe in cases of flow above the critical velocity. It then follows that the frictional resistances cannot be largely developed at the pipe wall, and must be distributed through the cross-section, in the shearing apart of the particles of the water itself, in which case they would, like the inertia resistances, depend upon the area. In either case the equation for a given pipe would be $R = xV + yV^2$ wherein x and y are supposed to be constants. Messrs. Saph and Schoder have discussed their experiments in the light of that equation as follows:

> In order to determine the values of the coefficients x and y, at least two methods have been in vogue. The first—the method of least squares—is allowable only on condition that the coefficients are proved to be constants, otherwise the formula derived and its limits of error apply only to those experiments which are used, and its application may be limited. The second method—a graphical one—is for this reason more general, but in most cases in which it has been applied it has not been carried to completion. It consists in obtaining first a series of equations in x and y by substituting the observed values of R and V. These equations may be represented by straight lines, and if x and y are constants, all these lines should pass through one point the coördinates of which are the desired values. Ordinarily, however, it is said that the lines will not pass through a point, but will enclose a small area, and in such a case the coördinates of the center of gravity of the area are the values of x and y. This method has been applied by the writers to a number of series of experiments, and in no case, if a suitable scale were used, did the lines pass through a point or enclose an area. In every case the lines formed a series of tangents to a regular curve similar to one branch of a hyperbola, and to which the axes were apparently asymtotic. This showed clearly that x and y, instead of being constants, were really functions of v. Further investigation also showed that x and y were always such functions of V that the final result was that obtained by a direct logarithmic plotting. For example, if the logarithmic plotting leads to $R = mV^{1.75}$, this method leads to $R = xV + yV^2 = (aV^{0.75})\,V + (bV^{-0.25})\,V^2 = (a + b)\,V^{1.75}$. If it is admitted that $Hf = mV^{1.75}$ represents accurately the relation, it can also be proved mathematically that any attempt to express the relation in two terms will lead to variable coefficients, and finally result in the same way as shown above.

The author on the other hand, in Chapter VIII, taking the classic experiments of Froude, on a board towed on edge through the water, proves the equation above to satisfy the several experimental results with $X = aL$, where a is a constant and L is the length of the board, and Y is constant for each series of experiments.

This is neither the time nor the place to attempt to harmonize the conflicting deductions from equally reliable physical data, but the writer would suggest that there is opportunity for considerable valuable research in the work of Messrs. Saph and Schoder.

Returning to the text, many interesting observations are cited in support of various of the author's conclusions, and among them the fact that the greasy-sided whaling vessels, which the water did not wet, always made faster time than other ships built on the same lines.

The book is one that should be in every hydraulic library, and not only be there but be read.

The Elements of Structural Design

Reviewed by LEWIS E. MOORE*

STRUCTURAL DESIGN—Volume 1: Elements of Structural Design. By Horace R. Thayer, Assistant Professor of Structural Design, Carnegie Technical Schools, Pittsburgh, Penn. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. vii + 221; 69 text illustrations. $2, net.

This book differs from the ordinary book on structural design in that it does not spend a great deal of time dealing with stresses in structures and methods of finding them. It presupposes a knowledge of mechanics, stresses and the mathematics on which they depend. It takes up the subject from the standpoint of what the designer and detailer must know about materials, shop-work and erection, in order to design and detail intelligently and economically.

The first chapter deals briefly with timber, explaining how it grows, its faults and weaknesses, preservative processes, strength and uses. The various kinds of iron and steel are dealt with in a similar manner, the chapter closing with a paragraph on paints. Chapter II takes up handbooks, units of measurement and the proper dimensioning of various kinds of materials. Commercial shapes of wood and iron are illustrated and the methods of rolling briefly described, including ways of increasing cross-sectional area. The principles of design are taken up briefly, showing proper, and to some extent improper, methods of construction. Washers, hangers and similar accessories are described, together with the design of joints and splices in wood. The design of a wooden roof-truss is briefly outlined, as well as the design of a king-post truss, a Howe truss bridge and wooden trestle bents.

Under the heading of "Fabrication of structural steel," the author describes the organization of a company formed for that purpose and gives plans and photographs of existing plants to illustrate the arrangement of buildings and tools. Examples of the various machine tools used are shown and described with especial attention to their uses and limitations. Shop processes are then illustrated briefly from templet work to shipment. Various methods of erection follow.

Under the caption "Engineering department," specifications are taken up in such a way as to indicate the points which should be covered by them. Economical relations of height to depth for plate girders and Pratt trusses are briefly treated in the usual way and with the usual more or less reliable results. A paragraph on what an estimate should include is followed by examples illustrating the design of various typical structural members. In this connection the author gives numerous illustrations of various types of members. An outline of the functions of a strain sheet precedes illustrated descriptions of the proper methods of detailing, including the placing and arrangement of dimensions on a drawing. Paragraphs on the preparation of shop bills, checking of drawings, and the examinations of existing structures follow and the book is closed by four or five pages devoted to an account of the failures of some bridges and buildings.

The author has succeeded admirably in taking up the subject from a new and unusual viewpoint for writers on structural design. His idea has evidently been not so much to teach how to figure stresses as to show how to design a structure which can be built at a reasonable cost in the ordinary structural shop in the United States. The book should prove very useful to a considerable number, not only of students and teachers, but also of practical men.

*Assistant Professor of Civil Engineering, Massachusetts Institute of Technology, Boston, Mass.

Heating and Ventilation

Reviewed by REGINALD PELHAM BOLTON*

MECHANICS OF HEATING AND VENTILATING—With Charts for Calculation and Examples. By Konrad Meier, Consulting Mechanical Engineer for Heating and Ventilating. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. ix-161; 36 text figures. $5, net.

A PRACTICAL MANUAL OF STEAM AND HOT-WATER HEATING—By Edward Richmond Pierce. Chicago, Ill.: Domestic Engineering Co. Cloth; 5½x8¾ in.; pp. 339; 30 text illustrations. $2.50, net.

The first of these two books is one of those patient compilations of a mass of theoretical materials dealing with a given subject for which engineers whose work lies along the lines of the industrial arts have cause to be grateful to the powers of analysis and willingness to labor which have been shown by the author.

The art in question, that of heating and ventilating, is one to which an increasing amount of attention has been devoted by theorists during the past decade, with the result that much of the available information as to methods of computation and ascertainment is scattered in a number of volumes, each valuable in itself, but in general covering some one particular part of the subject to a greater degree of refinement than others.

Mr. Meier has, with characteristic thoroughness, presented in his new book the theory of the movement of fluids grouped under the practical headings of the movement of Hot Water, Steam and Air, as required for practical or hygienic purposes.

The data thus brought together are admirably arranged and consecutively presented, and the several phases of the subject are grouped around a series of diagrams or charts, ingeniously prepared and covering a considerable range of the elements which affect the particular fluid under movement. Such diagrams have previously been presented by other engineers, particularly by German authors, and in the hands of those who are familiar with the nature of such a diagrammatic illustration of the subject, the method becomes one of considerable value for ready approximate computations, or for the visual checking of a more extended and exact determination.

In order, however, that such a result may be brought within the capacity of the ordinary reader, or become of practical value to such engineers as may not be so conversant with the use of logarithmical charts and methods as are the authors of such books, a necessary accompaniment to such diagrams is a simple and plain statement setting forth the method of their usage—a statement which is entirely lacking in the work under present consideration. This unfortunate feature detracts from the value to a great many people of these ingenious charts, since it is necessary, even to the initiated, in order to be sure that the method of reading such charts has been correctly interpreted, to check back by computation upon the series of observations, thus involving a considerable amount of work which might have been saved by a simple system of directions.

To those examples illustrated in the several figures in this book something of the same limitations must be applied, since the illustrations group numerals without indication of their character. When, however, these features become, by sufficient study, thoroughly understood, the value of the work which Mr. Meier has completed can be fully appreciated, and the usefulness of the book to the heating engineer becomes evident.

Particular commendation can be accorded to the presentation of the subject of hot-water heating, and particularly to that form of the subject of heating which involves the use of mechanical appliances to force the flow. In view of the wide extension of central-station heating systems, this subject is of immediate concern to a large number of heating engineers.

The author presents some suggestive thoughts on elements which ordinarily receive very little consideration, such as the heat imparted to the fluid by the friction of its passage, an increment of heat which in some cases may equal losses by radiation during transit. He concludes that "as a heat loss by convection along the mains is relatively smaller, while the resistance is relatively greater than that in the branches, it seems quite proper, under similar conditions, to make no allowance to the volume of water to cover the heat losses in mains."

Attention is directed to the interesting possibilities of the effect of the changes

*President, the R. P. Bolton Co., Consulting Engineers, 55 Liberty St., New York City.

of viscosity with the temperature of water, as possibly affecting the work of movement of the fluid; a subject upon which much remains to be ascertained by future investigators.

The subject of gravity heating by hot water is comprehensively presented and well illustrated by diagrams of various methods of piping. The entire presentation of this subject is not only helpful in itself, but illustrates the fact that by proper consideration of mechanical loss governing the movement of water, success may be secured in advance by proper design and proportion of hot-water heating systems.

These considerations apply equally to the study of the movement of steam, as well as of air. In the former, the wide range of discussion which has taken place over the whole subject of distribution, condensation and return systems, renders much of the material presented by Mr. Meier familiar to the reader; but his practical illustration of the methods of ordinary computation is strengthened by the inclusion of elements affecting the flow in the form of obstructions by fittings and valves, for which in common practice only empirical allowances are usually made.

The methods of computation applied to the preceding subjects appear in their natural form in considering the effects of the movement of air by gravity or under mechanical influence, but in this part of the subject the author uses, to quite a considerable extent, terms in formulas and text which, for the untechnically trained reader, require simplification or explanation. Without the use of such refinements, the ordinary reader would find the presentation of this part of the subject of much practical value, when, as has been said, the methods for the utilization of the ingenious diagrams presented, have been mastered.

On the whole, the book is a distinctly valuable addition to the determinate literature of the great art which so directly affects the industry, comfort and health of every person.

The purpose of Mr. Pierce, in his "Manual of Steam and Hot Water Heating," appears to be to restate the known and determined elements in the planning and proportioning of heating apparatus, in a simple form for the use of mechanics.

The first chapter, however, which deals with the fundamental matter of chimney proportions and draft, quite fails to inform the reader upon the methods of predetermination of draft, or proportion of chimney to grate area and fuel combustion. Table B gives sizes of flues proportioned to radiation in service. These sizes entirely ignore the vital element of height, nor is anything said as to the effects of horizontal connections or flues and the arrangement and effects of dampers. Variations in stack temperatures are used as a basis of comparison of output, regardless of the question of stack height and proportion. The reader is thus led to assume that a certain temperature of chimney gases is an accompaniment of the combustion of fuel at certain rates per square foot of grate, and this irrespective of the kind and size of fuel. Much of the material takes the form of criticism of so called ratings of boilers, but no practical substitute is afforded to the reader. The author says (page 246), referring to the "wide difference in the intensity of chimney drafts," that "it must therefore always rest with the heating contractor to select the boiler which will suit the chimney conditions." The whole discussion fails of its purpose in the absence of any indication to the reader of a method of ascertaining what the draft of any given chimney will be. In this connection, the author illustrates two forms of draft gage, neither of which is as simple as a bent glass tube which anyone can make without cost.

The author appears to have peculiarly retrograde ideas on the subject of hygienic ventilation, referring to "the craze for sleeping in rooms with the heat off and the windows open." He also seems to have a rooted objection to anything that looks like a formula, and asserts that "most elaborate algebraic formulas have been found necessary to express the loss of all kinds of building materials"—an extravagant qualification of the simple statements of heat losses through such materials, which are in customary use.

In his remarks on the effects of wind upon heating work, the author asserts that "a very serious discussion is demanded" but he devotes less than five pages to this subject, and gives no details of recent investigations of inward leakages, or of their effect upon interior change of air contents and in his final conclusions he directs the reader to add empirical percentages based on average wind velocities.

The general discussion of pipe sizes leaves the reader somewhat confused as to any determination, and the "Manual" lacks any indications or information on the important subject of piping systems and arrangements.

On the whole, the impression left by a perusal of the volume is one of confusion and of an unnecessary amount of criticism of recognized methods, for which methods very inadequate substitutes are afforded.

The historical descriptions are interesting, though somewhat erratic, and the claim of the author that he has "endeavored to bring out every fundamental principle involved in the science of heating" is by no means supported by the contents of his book.

An Elementary Book on Dredging

Reviewed by J. W. WOERMANN*

DREDGES AND DREDGING—By Charles Prelini, Author of "Earth and Rock Excavation," "A Treatise on Tunneling," etc.; Professor of Civil Engineering in Manhattan College, New York. New York: D. Van Nostrand Co. Cloth; 6¼x9½ in.; pp. 279; 82 text illustrations. $3, net.

The author has compiled and classified a large amount of valuable information covering a new field in book making. In his preface he states that "if one needs an excuse for offering to the profession this book, it is found in the vast importance of dredging in our commercial life. This treatise is written with a view of presenting the subject in a concise and logical manner, so that it may be found useful both to the man of experience and to the beginner or student."

It is a pleasure to concede that the subject has been treated concisely and logically and that it may be found useful to the beginner or student. The man of experience, however, is not likely to find in it anything of value in his own field. The engineer who has been devoting his time entirely to river dredging will find interesting descriptions and useful data relating to sea-going dredges, but he will be disappointed when he reads the chapters relating to his own specialty. This is due partly to "conciseness" and partly to the author's lack of familiarity with certain phases of the subject, but mainly to the woeful lack of typical plans and clear halftones.

The introduction or history of dredging covers only two pages, but is probably sufficiently complete to satisfy most engineers. Chapter I is devoted to the principal uses and types of dredges. The classification of dredges into continuous and intermittent is pedantic but harmless.

Chapter II contains elementary descriptions of the various kinds of material which may be excavated by dredging. The next chapter is devoted to soundings and hydraulic surveys, including automatic soundings by horizontal sweeps, place and scow measurement, and some data on increase and shrinkage of material. The fourth chapter describes rock excavation by the steam punch, the Scott & Godsir cutter and the Lobnitz cutter. The next chapter treats of rock excavation by small blasts, and includes brief descriptions of various drilling plants: Dunbar's, Saunders, Ingersoll's and Rand's. The halftone illustrations illustrate nothing clearly but the sky-line. Chapter VI treats of rock excavation by large blasts. The removal of Flood Rock at Hell Gate, N. Y., and Henderson Point in Portsmouth Harbor are described in detail.

*Assistant Engineer, W. Division, U. S. Army, 428 Custom House, St. Louis, Mo.

Chapter VII contains some excellent hints on the selection of dredges, but also several statements which are misleading, viz., on p. 51 the author states that grapple dredges will work in either *hard material* or soft soil. On p. 52 the language indicates that the simplest form of agitator for a hydraulic dredge is a revolving cutter. On p. 54 the author conveys the impression that on the Mississippi River the dredges follow up the "snag-pulling machines." Space will not permit the reviewer to clear up these points.

Chapter VIII is devoted to crews, quarters, and tenders. No plans are shown for quarters, however, so that this chapter is like an architect's book on dwellings with the plans left out. The language is too general and at times it is impossible to tell to which type of dredge a statement applies.

The next chapter is devoted to the classification and capacities of dredges, detailed descriptions of which are given in the subsequent chapters. In the chapter on ladder or elevator dredges, in giving the advantages of steel hulls over wooden hulls, the author omits the most important, viz., that on account of its longer life and less cost of maintenance steel is *cheaper*. The descriptions of ladders, buckets, towers, and methods of driving are good, but plans and photographs are again lacking.

There are only a few typographical errors and they will not bother the reader. The following, however, can hardly be laid to the printer: in describing sea-going ladder dredges the author says, "the hull is closed forward, the ladder remaining in the *bow* of the steamer both in navigation and in dredging."

Chapter XII is devoted to "Semi-sea-going, Stationary and High-Tower Ladder Dredges." By stationary the author means those which are not self-propelling. The cuts, as usual, are small and indistinct.

The general discussion on hydraulic dredges should be rewritten. Take for example the following sentence on p. 95: "The suction tube proper, which forms the real communication between deck and bottom, is composed of several sections of wrought-iron pipe from 10 to 20 in. in diameter, the size depending upon the efficiency of the dredge." Four corrections are needed: (1) the "suction tube" does not connect the deck with the "bottom"—whether the author means the bottom of the dredge or the bottom of the river. (2) Suction pipes as large as 30 in. to 36 in. diameter have been in use for many years. (3) Steel pipes are preferable to wrought-iron because they are cheaper and more durable. (4) Instead of "efficiency" the author means capacity. In the chapter on sea-going hydraulic dredges the statement is made that wooden hulls are better able to resist pounding on shallow bars than steel hulls. The experience of years on the Mississippi below St. Louis has demonstrated just the reverse.

The chapter on hydraulic dredges for river improvement contains a description of the dredge "Delta" from a "paper by Mr. Ockerson." In view of the fact that this exhaustive paper and discussion cover 140 pages and will always have great historical value, the failure to give the reference seems a serious omission. It will be found in the *Transactions* of the American Society of Civil Engineers, Vol. XL (December, 1898).

Chapter XVI contains good descriptions of two "universal dredges," i.e., each dredge is equipped with machinery to excavate by means of a chain of buckets, or by a centrifugal pump. The next chapter is devoted to "stirring dredges" —scrapers, harrows, revolving wheels, screw propellers, jets, etc., where the movement of the spoil is effected by the force of the current. All of these types are obsolete and have now only a historical value. Pneumatic dredging, in which air and water are mixed in the discharge pipe, is suitable for excavation for bridge piers but is too expensive for rivers and harbors.

In the general description of dipper dredges it is stated that the hulls are always made of wood, which is disproved by the author's own description of the steel hull dipper dredge "Majestic," which will dredge 40 to 50 cu.yd. per hour of soft limestone without blasting. Some good cuts are given of a small dipper dredge with bank spuds. This is followed by some excellent capacity and cost data.

In the discussion of grab dredges one of their several advantages has been overlooked. They are not only simple and cheap and peculiarly adapted for great depths, but they may be readily built with very long booms or mounted on cableways and are then adapted for various purposes to better advantage than any other type. An unusual arrangement of clamshell dredge is shown in the "Champion," whose bucket is opened and closed by means of a pneumatic cylinder.

Chapter XXIII is devoted to the transportation of the "débris" or spoil. Only one type of pipe line is shown, however, and the illustrations of barges and scows are merely diagrams; the form of construction is not shown.

In the chapter on methods and cost of river dredging the improvement of the St. Lawrence River is described in detail. A list of the plants is given, together with the cost of construction and operation. Tables are given showing the itemized cost of operating each dredge. The Mississippi River, however, with its fleet of twelve large dredges below St. Louis and an equal number of smaller dredges above that point, is omitted.

The next two chapters are devoted to the use of dredges in mining operations, the dredging of sand and gravel for building purposes, and the filling of low lands by hydraulic dredging.

The chapter on "dry-land dredging" is very sketchy. A cut is given of one type of drag-line scraper, but it is labeled "Bucket for Dry-Land Dredging," and their method of operation is not illustrated. The Austin drainage excavator is illustrated and several other ditchers are briefly described.

In Chapter XXVIII cost of operation, repairs, loss of time, interest, sinking fund, insurance, taxes, annual overhauling, and general expenses are briefly discussed.

The last chapter is the best in the book, and consists of a compilation of 14 pages of cost data relating to most of the types of dredges previously described. An index of five pages is a valuable part of the book.

A bibliography of the principal articles on dredges and dredging which have appeared in the technical journals during the last twenty years would prove a valuable addition to the book. Many of these have been drawn upon by the author, but the exact reference is not given. Such a list should call attention to the excellent papers and discussions on this subject presented before the International Engineering Congress in St. Louis in 1904, covering 252 pages in the *Transactions* of the American Society of Civil Engineers, Vol. LIV, Part C, 1905.

PUBLIC UTILITY LAWS AND COURT DECISIONS—Proceedings of the 23d Annual Convention of the National Association of Railway Commissioners. Digest of Decisions of Federal and State Courts pertaining to and construing the Interstate Commerce Act (as amended) and Acts Supplementary Thereto; Safety Appliance Acts, Arbitration Act, etc., and the State Laws Pertaining to Railway and Public Service Commissions. Chicago, Ill., and Washington, D. C.: Traffic Service Bureau. Buckram; 8x11¼ in.; pp. 1507. $7.50; leather, $10.

Anyone who doubts the activity of our state legislatures in passing laws designed to regulate railways and other public-service corporations should consult this volume which, among other valuable information, contains 1425 large closely printed pages of statutes on the subject enacted by our 49 states, including the District of Columbia. The Interstate Commerce law and its various amendments is also given. In addition, there is a condensed digest (some 120 pages) of federal and state court decisions on federal and state railway and public-service legislation.

The 1911 *Proceedings* of the National Association of Railway Commissioners occupy 100 pages of the volume. As will be evident to all interested in the subject the volume as a whole is one of the most useful compilations which has ever been published.

Bridge Problems—Structural Engineering

Reviewed by LEWIS E. MOORE*

SUSPENSION BRIDGES AND CANTILEVERS—Their Economic Proportions and Limiting Spans. By D. B. Steinman, C. E., Ph. D.; Assistant Professor of Civil Engineering at the University of Idaho, New York: D. Van Nostrand Co. Boards; 3¾x6 in.; pp. 185. 50c., net.

THE MECHANICS OF BUILDING CONSTRUCTION—By Henry Adams, M. Inst. C. E., Inst. M. E., F. S. I., F. R. San. I., M. S. A., etc.; Examiner to the Board of Education (London). New York, London, Bombay and Calcutta: Longmans, Green & Co. Cloth; 5½x9 in.; pp. xi + 240; 590 text figures. $2, net.

Prof. Steinman's book is essentially a study of a problem which the author proposed to himself. The problem as he stated it to himself was to determine the maximum span possible for both cantilever and suspension bridges, and also to determine the economic range of span for which each of these types of construction is best suited. The discussions given by various writers are quoted, and finally the writer himself undertakes to determine in addition to the maximum possible span for suspension bridges and cantilevers, the maximum economic span for each type and a span of equal cost for the two types. The method used was to prepare designs and estimates of a wide range of cantilever and suspension bridges and to deduce therefrom the variations of cost and weight with different lengths of span.

In connection with the study of suspension bridges, the writer discusses the relative merits of wire cables and eyebar chains and states the advantages and disadvantages of the braced-cable type. He then discusses the economic ratio of rise to span, finding as a result that the ratio of ⅛ generally recommended for ordinary spans is correct. The question of allowable stresses is discussed and a formula deduced for the allowable stresses in terms of span length, the author arguing justly that the longer the span the higher the working stresses may safely be. He brings out the point that the depth of the stiffening truss is a very important factor in the economical design of a suspension bridge. He then takes up the design of suspension bridges, giving simply methods and results in the text and including the design of towers and other essential parts.

Cantilever bridges are taken up in a similar way and the results of the author's designs are indicated. His estimates of costs are said to be based on a careful study of the estimates of construction of the large New York bridges. In his determination of economic spans, due regard is paid to the possible traffic and the revenue produced therefrom. Curves of the cost of suspension bridges and cantilever bridges for various spans are drawn. On the curves are indicated the economic limits and the span of equal cost for each type, which he finds to be 1670 ft. under his assumed conditions.

A study of this kind depends for its value upon the fundamental assumptions underlying it. The author has endeavored to equalize external conditions as to cost of material and particularly of foundations in order to remove as many uncertainties as possible. Bearing in mind the limitations necessarily imposed by these assumptions there seems to be no reason to question the conclusions at which the author arrives. In any actual case, of course, the foundation conditions might so alter the actual cost of the structure that this study might be misleading. It must be interpreted with care and with proper interpretation should prove a valuable help in the study and design of long spans. The bibliography is excellent and the book is worth its cost for the bibliography alone.

The book by Mr. Adams is based on a series of lectures which the author gave in the summer of 1906 to a number of science teachers selected by the Board of Education from all parts of the United Kingdom "with the object of perfecting their knowledge of the subject and at the same time illustrating the manner in which it should be taught." In preparing the lectures for publication the matter in them was expanded and explained more in detail so that "what was originally prepared for teachers only is now available also for students." The book is divided into 30 lectures or chapters. The first five chapters are devoted to the mechanics of forces in equilibrium, graphic statics, moments of inertia, etc. In the remaining and larger portion of the book the author has attempted to cover practically every kind of structure met with in the design of buildings from rolled beams to domes, including cranes and derricks of various forms. The last chapter is devoted to reinforced concrete.

Some of the author's statements merit particular notice. One is that the modulus of rupture "is, however, *from some causes which are not clearly understood,* generally in excess of the tensile strength, and has to be found by experiment for each material." The reviewer ventures the opinion that the reason for the non-agreement of the modulus of rupture with the tensile strength is taught in every American technical school worthy of the name. Perhaps the most noticeable error into which the author falls is in the finding of the reactions on a "cambered girder" which, from the conditions he assumes, is essentially an elastic arch rib. He takes a single concentrated center load and makes the lines of action of the reactions at each end intersect the load on the center line of the girder. This solution is beautifully simple and, of course, absolutely wrong.

Taken as a whole the book is not clearly written and gives the impression of covering a considerable territory in an irregular and rather superficial manner. It concerns itself rather with the solution of special problems than the clear elucidation of fundamental principles. In some of the problems the fundamental principles upon which the solutions are based are wrong. The book is decidedly not an addition to the literature of structures and in certain cases would prove misleading to one who did not study it critically with some previous knowledge of the subject.

*Structural Engineer, Assistant Professor of Civil Engineering, Massachusetts Institute of Technology, Boston, Mass.

A New Circle Graduation

Reviewed by JOHN F. HAYFORD*

FERGUSSON'S PERCENTAGE UNIT OF ANGULAR MEASUREMENT, WITH LOGARITHMS; ALSO A DESCRIPTION OF HIS PERCENTAGE THEODOLITE AND PERCENTAGE COMPASS—For the Use of Surveyors, Navigating Officers, Civil and Military Engineers, Universities and Colleges. By John Coleman Fergusson, M. Inst. C. E. London, New York, Bombay and Calcutta: Longmans, Green & Co. Cloth; 6½x10½ in.; pp. lxvii + 467; five plates and 12 text figures. $20, net.

This book is the outcome of 19 years of labor. Hence one is loath at first to comment unfavorably upon it. But such sentences as the following tend to remove the unwillingness: "It shows a lack of comprehension to assert that the ordinary theodolite divided in degrees is as good as or has one single advantage over the percentage theodolite" (p. XLVI). The percentage theodolite is the particular instrument advocated by the author.

The book consists of about 40 pages devoted to advocating a peculiar method of graduating circles used for measuring angles, of about 14 pages setting forth the corresponding methods of computation and their supposed advantages, of 460 pages devoted to very extensive special tables carefully prepared for use with this method, and of 20 pages of miscellaneous matter.

In the method of graduating which is advocated the circle is first divided into octants. Each octant is graduated separately into 100 unequal spaces, the zero numbering of the graduations being placed at the north, south, east and west points of the circle. Imagine tangents to the circle to be drawn in both directions from each of the four points named. These together will form a circumscribed square. Divide the portion of each tangent line from the point of tangency to the corner of the square into 100 equal parts. Imagine these points of division each to be connected with the center of the circle by a straight line and that the graduations are placed on these lines. In each octant the numbering on the gradua-

*Director, College of Engineering, Northwestern University, Evanston, Ill.

tion is, therefore, proportional to the tangent of the angle, varying from zero for the zero angle to 100 for the angle 45°, of which the tangent is unity. Graduated circles of this character have been made and used by Mr. Fergusson. On such circles a vernier is impossible on account of the variable spacing of the graduations. Mr. Fergusson uses in place of a vernier a slow-motion tangent screw, to which is attached a complicated special device.

The controlling idea which led to the advocacy of this graduation is that if the zero of such a graduation is placed in the direction of the line run, then the length of any rectangular offset from the line is equal to the distance from the instrument to the base of the offset times the reading of the circle, if the circle reading be considered to be in hundredths, or percentages. The tangent of the angle being thus read directly from the circle, the use of any table is said to be avoided. This advantage is assumed to predominate greatly over all other things, and all methods of computation and observation are to be radically modified accordingly if the views of the author are accepted.

The author seems to be somewhat blind to various new difficulties which will be caused by the proposed change, as, for example, those due to the graduation being continuous through the separate octants only, not around the whole circle, and those due to the fact that percentage angles cannot be subtracted or added, and cannot be measured by the method of repetitions.

As a matter of fact, even on the author's own showing the advantages of such a graduation are very slight. In the example given by the author (p. XXXVI) of the computation of the latitudes and departures of the points of a traverse, logarithms are employed, thus involving the use of tables, and the computation is not appreciably shorter than if the angles had been measured in the ordinary units.

The proposed graduation leads to simplified computations when applied to the vertical circle of an engineer's transit. From readings on two points of a distant vertical rod made with such a vertical circle the distance to the rod and its elevation referred to the instrument may be computed very simply. But such observations are necessarily of much less accuracy than the stadia observations which they are intended to supersede.

The greater part of the book, as already stated, is devoted to extensive special tables which the author has found to be necessary. These tables show for various "percentage angles" the logarithms of the corresponding tangents, sines, secants and cosines, with tabular differences. They also show the equivalent of each angle expressed in degrees, minutes and seconds. The tables have no apparent value except for use with instruments graduated in percentage angles.

Certain symptoms are fairly reliable indications of excessive riding of a hobby, and this book contains many of them. For example, it is asserted (p. LXIV) that "The difference between the Percentage Unit and degrees, minutes and seconds may be explained as the difference between arithmetic and algebra," and later it is stated that "The whole difference between the arithmetical and algebraic systems may be made clear by a simple example:

"A gives X £500 sterling for a half share in the sixth interest that X holds in a mining claim located at Eureka, Nev., U. S. A. It is plain to everybody that X has received £500 sterling for the half share of his mining interest. A, on the other hand, has got for his money an acknowledgment, which, in itself, is a concrete function implying value; and this implied value is dependent on the geological formation of a piece of ground staked out in Nevada, the true value of which A may determine by the aid of a Philadelphia lawyer and a Western mining expert. A has received *implicit* value; X got *explicit* value."

Theoretical Mechanics

Reviewed by ROBERT FLETCHER*

INTRODUCTION TO ANALYTICAL MECHANICS—By Alexander Ziwet and Peter Field, Ph. D., Professor and Assistant Professor (respectively) of Mathematics in the University of Michigan. New York: The Macmillan Co. London: Macmillan & Co., Ltd. Cloth; 5x7¾ in.; pp. 378; 96 text figures. $1.60, net.

This volume is based upon the larger work of Ziwet on theoretical mechanics, omitting applications to engineering. No knowledge of differential equations is presupposed. The high praise which the larger treatise has received is equally merited by this.

In an excellent introduction of five short paragraphs, giving the essential definitions, we are told that: "The science of Mechanics may be regarded as an extension of geometry by adjoining the ideas of *time* and *mass* to the idea of *space*." The idea of *measurement* of the quantities should also be emphasized to make the definition more complete.

The simpler operations of the calculus are used to develop the principles discussed. The method of the authors seems to be to make the demonstrations as brief as possible and leave some of the elaborations common in so called "elementary" works to be deduced by the stimulated thinking of the student or suggestions of the teacher. Principles which in some books are worked out, embodied in special equations and discussed, are here simply put in form of "exercises" to test the students' grasp of the subject. Hence some familiar expressions embodying important principles appear only as answers at the back of the book. The examples are scattered in small groups throughout the book in their proper relation. There are forty such groups comprising 322 "exercises" and problems, well selected and calculated to maintain interest and logically develop the principles. However, some of these seem to be difficult enough to tax the powers of the most advanced student, and therefore rather deep problems for an "introductory" treatise.

While elaboration of demonstrations is distinctly avoided, appropriate and brief explanations and suggestions are given in smaller type, wherever they may be needed or helpful. There are about 50 of these subsidiary discussions and diversions, showing how well the authors understand the "art of putting things."

The authors state that: "The aim has been not only to select material useful to the beginning student of mathematics and physical science, but at the same time to give the reader a general view of the Science of Mechanics as a whole, a broad enough foundation for further study." The authors also state that "the book can readily be covered in a three-hour course extending throughout the year," and suggest a shorter selected course for about half of this time. The question might be raised whether "junior and senior students in college," for whom the book is intended, who are able to appreciate and master it, would need so much time; unless it is proposed to "exercise" the pupil systematically in elucidating all of the problems, including many that are more curious than useful.

Average students of engineering often do not have time or inclination to pursue purely theoretical mechanics very deeply, apart from the applications. It would seem that a work like this would be more useful and acceptable to all classes of students if it included at least a few pointed allusions to practical cases and striking illustrations of the principles presented. For instance, the equilibrium of the swinging door determined by the balance of couples in different planes, including the hinge plates, and transference of stress to the holding screws; actual acceleration tests of electric motors and of trains; a little more discussion of friction and its effect in modifying theoretical results, etc.

A book on "Woodworking Safeguards" (paper bound, 200 pp.) has been compiled by David Van Schaack, director of the Aetna Life Insurance Co.'s bureau of inspection and accident prevention and is published by that company at a price of one dollar. In addition to descriptions of safety devices for woodworking machinery and the power equipment of a woodworking plant, there is a chapter on safeguards for the prevention of logging accidents.

*Professor of Civil Engineering; Director of Thayer School of Civil Engineering, Dartmouth College, Hanover, N. H

A Misnamed Compilation

(CONTRIBUTED)

THE SUBWAYS AND TUNNELS OF NEW YORK: METHODS AND COSTS—With an Appendix on Tunneling Machinery and Methods and Tables of Engineering Data. By Gilbert H. Gilbert, Lucius I. Wightman and W. L. Saunders. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; p. xiv + 372; many plates and text illustrations. $4, net (17s., net).

This book contains some 380 pages of matter. One-half of the total is devoted to subways and tunnels in New York, and this is almost without exception a direct copy of random extracts from various papers contributed to the American Society of Civil Engineers. There are 181 pages of so-called subway and tunnel matter, and 181 pages of appendices dealing with the usefulness of compressors, drills and pumps; there are about 60 general illustrations and about 60 in which pumps, drills and compressors are the chief features. Even in the descriptive part of the book, extraordinary emphasis is laid on the compressed-air plant of the undertakings.

The chapters are divided in a haphazard way. The sources of information of several of the chapters are not even acknowledged; the other sources are not acknowledged in the manner stipulated by the American Society of Civil Engineers for reprints of its papers.

The title of the book is misleading; a truer title would be "Drills, Compressors and Pumps, with Reprints from Technical Papers on Subways and Tunnels in New York."

The publishers distribute by mail a card advertising the book and stating that the triple authorship is a guarantee of its character. The statement is hardly to be denied, as concerns the character of the book, though the word "author" is quite out of place. The first of the so-called authors appears to be a present employee of a rock-drill company, who, it is stated, "knows from experience the kind of information which engineers and contractors need and are seeking"; the second is a mechanical and publicity engineer, now or formerly an employee of the same company; and the third is the president of the same company. That any of the three is in any sense an authority on subway and tunnel work is not evident.

Some trace of authorship, as concerns subways and tunnels, appears in the shape of a "Tribute" on the first page, and in two or three pages following. The "Tribute" contains a eulogy of D. E. Haskin, C. M. Jacobs and W. G. McAdoo; however well this may be deserved, it would have been more appropriate in a book of other character than this one.

The Pennsylvania part of the book takes up 110 pages of the 181 devoted to subways and tunnels. As already remarked, all of this is directly copied from the two volumes of *Transactions* of the American Society of Civil Engineers. The part given over to the Hudson and Manhattan tunnels is less complete, and the paper of C. M. Jacobs before the Institution of Civil Engineers does not appear to have been consulted. The part dealing with the Belmont tunnel seems to urge chiefly the need for a particular make of pumps and a particular make of compressors.

There can be no essential objection to a compilation of writings on any subject. In particular, a compilation of literature concerning tunnels and subways of New York City alone, dealing fully with the Hudson tunnels, the enormous system of the Interborough, the Belmont tunnel, the Blackwell's Island tunnel, the Hell Gate tunnel, the Pennsylvania tunnels, and so on, might be of much use, especially to those who are not members of the engineering societies. But the present book can hardly claim to be even a compilation. The text gives every evidence of having been thrown together in extreme haste. Apparently, various technical articles were collected and, without the guidance of practical experience, they were worked into a jumbled mass, in which some parts were expanded and others condensed, on no particular plan. The real authors of the matter used in the book have quite a serious grievance against either the compilers or the publishers, for this treatment of their writings.

Even if the book be regarded as a compilation, however, the compiling is so defective, so hurried and incomplete, that its utility quite disappears. To set forth adequately the works with which the book purports to deal, vastly more information would need to be given. The operations and their methods, and the costs of the undertakings, cannot be understood or appreciated on the basis of this fragmentary and badly mangled material.

Most of the appendices, occupying half the book, have absolutely nothing to do with the subways and tunnels of New York. On the other hand, they may cause the book to be of use to some engineers as a compilation of matter on certain kinds of machinery. For, the appendices contain a great deal of information; though most or all of it has been published before, its collection here may make it a useful reference.

In any case, if engineers (or others) desire such a book as this it should be placed under a suitable title and advertised correspondingly. No doubt the majority of our young engineers are affiliated with the American Society of Civil Engineers. If any of them should buy the book from its title or the advertising circulars, they would find, on parting with their hard-earned money, that they already possess practically all of it—and much more—in the published *Transactions*. The engineer, especially the young one, finds it hard enough to buy the books he needs, and hard enough to find information after he gets them. Viewed merely from his standpoint, the making of books of this kind is decidedly unfortunate.

A Study of Water Waves

Reviewed by D. W. TAYLOR*

WAVES OF THE SEA AND OTHER WAVES—By Vaughan Cornish, Doctor of Science (Manchester Univ.) Fellow of the Royal Geographical, Geological and Chemical Societies of London; Member of the Japan Society. Chicago, Ill.: The Open Court Publishing Co. (378-88 Wabash Ave.) Cloth; 5⅜x9 in.; pp. 374; 55 text illustrations. $2.50, net.

Three more or less distinct subjects are treated in this book. Part I, containing 140 pages, is devoted to the size and speed of deep-sea waves; Part II, of 80 pages, to "the action of sea waves to transport shingle, sand and mud"; and Part III, of 148 pages, to stationary and progressive waves in rivers. There is an index of six pages.

In the section devoted to deep-sea waves, which of the three subjects treated is the one of the most general interest, the author, while giving results obtained by previous observers, discourses mainly of observations made by himself in a number of voyages in various parts of the world. His conclusions as regards wave heights to be expected in the North Atlantic are that the larger waves in ordinary North Atlantic storms attain 43 ft. and in exceptional storms both in the North Atlantic and in the South Indian Oceans attain, and perhaps surpass, 45 ft.

The method of observation adopted by the author was the common one. He placed himself at such a height aboard ship that the larger wave crests were just about in a line with the horizon and then assumed that the wave height was the same as the height of his eye above the smooth water line of flotation of the ship. This method can only be regarded as roughly approximate. As indicated by the author himself, a large vessel does not rise to the full height of the wave crests or sink to the full depth of the hollows, so that the method is almost certain to underestimate the wave height from hollow to crest.

The author points out that in the North Atlantic he was very seldom able to observe long waves and says that he has never, during 11 voyages across the Atlantic, seen waves which appeared to him to be nearly as long from crest to crest as the 600-ft. ships upon which he has voyaged, nor indeed, which appeared more than 400 ft. in length. He also brings out a fact frequently ignored that, in a storm at sea, particularly when it is rising, it is not regular; that is to say, the waves do not run as long ridges at

*Naval Constructor, U. S. N., Quarters "R," Navy Yard, Washington, D. C.

right angles to the wind. The ordinary rough sea is simply an exaggeration of the kind of sea seen in white-cap weather. The waves consist of comparatively short lengths of ridges rising to peaks, and the whole motion is confused and irregular. After a storm, however, the tendency is for the waves to get together to form a regular sea.

Only once in the course of his 11 voyages across the Atlantic did the author observe a regular sea, and apparently this was a case where a second storm took hold of the regular sea left by the passing of an earlier one.

The mechanics of the process by which the short irregular storm sea is transferred into the long regular sea, or swell, following a storm is not well understood.

The author, on page 89, gives information as to a series of heavy breakers which he observed in 1898 upon the English coast. The observed intervals between these breakers varied from 12 seconds to 28 seconds, the average being 19 seconds, corresponding to a wave length in deep water of 1850 ft. At another place the author gives an average period of 22 seconds, the longest ever observed by him for a group of breakers, corresponding to a wave length in deep water of 2594 ft. These lengths are as great as those claimed for the giant waves in the neighborhood of Cape Horn and the Cape of Good Hope, where in latitudes far enough south it is possible for a wave to travel 360 deg. of longitude indefinitely.

The author explains these immense wave lengths by supposing that in a storm there are really a number of series of waves both of the long and the short length. A more probable theory would seem to be that the actual waves do not form in any sense a regular series since they differ in length and height and that after a storm the larger waves absorb the smaller waves as they catch them up so that the crests of the final swell correspond only to the larger crests of the original disturbance.

Even in steady trade winds which had blown for days the author found that the sea was not made up of regular ridges. The irregularity of a rough sea and the fact that when the wind is blowing the ridge of a given wave does not extend any great distance are ascribed by the author to the unsteadiness of the wind, to the fact that even in an apparently uniform wind the direction is constantly wavering. It appears more likely that the irregularity is due to the fact that an accidental irregularity when the waves are very small, once started, tends to develop, and once peaks are formed, no matter how small, the peaks grow faster than the lower portions of the wave ridges, which ultimately disappear.

Part II, dealing with the motion of sand, shingle and mud caused by waves, is interesting, but appeals to very few people.

The author explains why, upon a beach where there is both sand and shingle, the latter is piled up at the top of the beach and the ordinary beach consists mainly of sand, finer matter such as mud going out to sea.

On some beaches there is a peculiar arrangement of the pebbles and shingle, they being distributed along the beach by sizes. The author has investigated this matter and finds that in such beaches the largest pebbles and small stones are to leeward, so to speak, from the direction of the largest waves which strike the beach, which naturally come from the direction where there is the greatest distance of open water.

His theory, which seems altogether probable, is that the heavy waves transport both the fine and the coarse material along the beach and the smaller waves from the other direction carry back only the finer material. From observations with brick-bats the author found that even in very moderate weather upon a beach on the southwest coast of England a brick-bat would travel nearly a fifth of a mile a day along the beach.

Part III, devoted to stationary and progressive waves in rivers, is interesting but not very conclusive.

It is difficult to convey an adequate idea of such phenomena in words and although the text is supplemented by a number of illustrations, photographs of water, in the reviewer's experience, convey ideas very different from those formed from actual observations.

A good deal of space is devoted to the author's observations of the tidal bore of the Severn River, in England. The waves in the Whirlpool Rapids, at Niagara, have been studied and are described and investigations of waves in certain Swiss conduits are described.

In one conduit about 15 ft. wide, and 1360 ft. long, the water flows rapidly about 3 in. deep, the slope being nowhere less than 1 in 14. Wavelets are inaugurated by the roughness of the bottom at the beginning of the conduit and grow steadily as they pass toward the lower end.

The author found that at the beginning of the conduit the waves passed at the rate of 120 per minute, being practically ripples. After a distance of five or six hundred feet the waves form a distinct series, there being nearly 33 per minute, while at the end of the conduit, 1361 ft., the waves have been reduced to 17 per minute. The disappearance of such a large proportion of the original waves is accounted for by the author's observations that the larger wave crests catch up the smaller and swallow them, as it were. This is an interesting investigation and suggestive conclusion. It is quite probable as already noted that a similar process goes on at sea after a storm has passed, tending to reduce the confused sea to a regular and much longer one.

The author is evidently an enthusiast and has produced an interesting work, although one of little practical value to the engineer.

There are a number of excellent photographs reproduced in the book, but the charts showing the beaches explored by the author, the Severn River, etc., have been reproduced from large scale charts and some of them are so small as to be almost illegible without a magnifying glass. In the lengthy description of the phenomena at Chesil Beach, several places are mentioned that do not appear to be on the chart.

The typographic work of the book is excellent and but one blunder was noted, near the top of page 306, where "second" should evidently have been "minute."

REINFORCED CONCRETE DESIGN—By Oscar Faber, B. Sc., A. M. I. C. E., A. C. G. I., and P. G. Bowie, A. C. G. I., Chief Engineer and Assistant Engineer (respectively) to Messrs. Trollope and Colls, Ltd., London. New York: Longmans, Green & Co. London: Edward Arnold. Cloth; 5½ x 8½ in.; pp. 332; illustrated. $3.50, net.

As its title implies, this book is devoted purely to the design of reinforced concrete. Only such details of material composition and strength and construction methods are given as are necessary to explain the various theories of design. The fundamentals of design, as given in the book, are the same as the ones commonly used in this country, but the greater part of the volume is given over to the most rigid investigation of the stresses existing in reinforced-concrete beams and columns under varying loads and with varying degrees of continuity. The authors particularly insist on a more rigid analysis of reinforced columns as a part of a continuous structure of which the beam is the other part. This analysis into the secondary stresses developed by such rigid connection is made for all possible conditions of the structure, and a lengthy appendix is given over to further involved algebraical discussion of the moments in various types of continuous beams. Following this theoretical discussion are a few short chapters upon reservoirs, retaining walls, specifications, etc.

The stresses in reinforced concrete are notably involved. To determine them, it is necessary to make a great number of assumptions which in any particular construction may or may not be correct. However, on account of the known variation in the material itself, it has usually been thought that a very rigid analysis of stress is hardly desirable. On the other hand, if an engineer wishes to make such rigid analyses and to take care in his design of the variations of the material in some other manner, we know of no other text-book which will aid him in studying the analyses equal to the one noted above.

Translation of a German Book on Varnish Manufacture

Reviewed by ROBERT JOB*

GERMAN VARNISH MAKING—By Prof. Max Bottler, of Würzburg. Authorized translation with "Notes on American Varnish and Paint Manufacture," by Alvah Horton Sabin, M. S., M. Am. Chem. Soc.; A. S. Testing Materials, etc.; Consulting Chemist, National Lead Co. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5½x8¼ in.; pp. vii + 363; 55 text figures. $3.50, net (15s., net).

The translator's preface shows the need of a work in English on the subject of varnish making, by the statement that for several years information as to progress in the manufacture of varnish in Germany has been obtained only through the German journals, which are not generally accessible in America, and that, therefore, the publication of a new book on the subject by Prof. Bottler, who has made a scientific and practical study of the subject, calls for an English translation.

After an historical review of varnish, a classification of lacquers is given, and a description of each of the principal materials used in varnish making, with a useful table of the chemical properties of the resins generally used in varnishes.

Directions are given in the chapters on Making Lacquers and Varnish so that some, at least, of the pitfalls to which the varnish manufacturer is liable may be avoided, and in the chapter on "Oil Varnish and Oleo-resinous Varnishes" various types of apparatus are shown, including plans adopted for removal of noxious vapors. Also, formulas for the preparation of a number of varnishes for different purposes are stated.

Turpentine and benzine varnishes, such as asphaltum varnish and caoutchouc varnish, are also considered, and also the method of manufacture of alcoholic and other volatile varnishes, as for instance, those for book-binding, and for photographic use, gold lacquer and many other kinds. Directions are also given for the coloring, bleaching and filtering of lacquers and varnishes, as well as for the manufacture of printers' ink, lithographic varnish, soap, resin and casein lacquers.

A chapter by Sabin follows with Notes on Varnish Making, and much useful information, while a discussion of Paint, its Constitution and Nature makes an interesting statement of generally accepted theories upon this subject which will be of value to the paint student, as will also the description of Thompson's "Classifier," an apparatus by means of which the particles in a given pigment may be grouped in their relative sizes. The author details characteristics of various paint pigments, but he does not appear to mention the well demonstrated fact that the so called "mixed pigments," namely, mixtures of white lead, zinc oxide, with or without admixture of various "inert" pigments, prove much more durable in service than either white lead or zinc oxide alone.

A useful chapter on analytical methods of Analysis of Pigments follows, and the author concludes with Crockett's Varnish Formulas and with an index.

*Vice President, Director of Laboratories, Milton Hersey Co., Ltd., Chemists and Mining Engineers, 171 St. James St., Montreal, Canada.

A Sumptuous Book on Town Planning

CIVIC ART—Studies in Town Planning, Parks, Boulevards and Open Spaces. By Thomas H. Mawson, Honorary A. R. I. B. A., Lecturer on Landscape Design at the University of Liverpool. London: B. T. Batsford (95 High Holborn). New York: Chas. Scribner's Sons. Cloth; 9½x14½ in.; pp. 376; 272 illustrations. $20, net. (50/- net).

From having no books on civic art our British cousins have within a few years come to have three notable examples* besides the minor books on Garden Cities.

As a piece of artistic bookmaking, the book before us, in its stately folio form, with many diagrams and numerous magnificent halftone engravings, is by far the most notable production of the three. The subject matter of the text is not so readily compared, because each book has a plan and scope different from the others. In our review of the two earlier British books (Mar. 17, 1910) we characterized the one by Triggs. As the briefer and simpler of the two and therefore as serving as a possible introtion to Mr. Unwin's book. Mr. Mawson justly characterizes his own sumptuous volume as "supplementary to the many excellent works recently published, which treat more adequately than is possible in a work of this nature of the historical, sociological, engineering, and scientific aspects of the subject." He adds that his present book is designed to be supplementary, also, to his own earlier "The Art and Craft of Garden Making."

The author first gives his ideas of the Theory of civic art in four chapters, then presents Practice in eight more. The latter deal with the general survey and traffic circulation of the town; civic centers, open spaces, and garden spaces; public monuments and street equipment; boulevards and street planning; the design and construction, adornment and equipment of parks; and finally the property owner in relation to town development.

These twelve chapters abound in references to illustrative examples distributed through the whole volume in the form of diagrams or maps and halftone views and pen sketches drawn freely from the best examples of England and the continent. They are followed by seven Examples of Town Planning and six Examples of Public Parks and Town Gardens. These examples are taken largely, but not wholly, from the author's tendered or accepted designs, which are also freely cited in the earlier part of the book. The examples include, among others, an improvement scheme for Dumferline, Scotland, under a Carnegie gift; Port Sunlight; gardens or parked spaces surrounding the Carnegie Palace of Peace, at the Hague; and parks at Hanley and Barton. The Palace Garden designs were the result of a competition in which Mr. Mawson won first place.

Appendixes give selected lists of trees and shrubs for parks, streets, and special positions and soils. Finally, there are two carefully prepared, detailed indexes, one to the many illustrations and one to the text.

Most of the illustrations are all that could be desired, but some of the plans might readily have been more legibly lettered for reproduction. The smaller pen-and-ink sketches are generally satisfactory, but some of the large and pretentious ones, as well as some of the more pretentious headpieces, impress the reviewer as ugly in their penwork, although correct in outline. The type is large, clear and handsome; the press work, paper and binding are also worthy of so sumptuous a book—to which character each and all, of course, contribute.

The printed page has one fault common to all folios which do not use a double column of type matter; that is, a length of line ("measure") difficult for the human eye to take in. In this case the line is seven full inches in length, and difficult to follow, notwithstanding the large open type and heavy leading. Where illustrations break the text this fault is largely and, in some cases, wholly obviated; this device might well have been resorted to more frequently.

The question naturally arises, has not the day for the immense folio passed?—even in the case of books which will find their way in small numbers into libraries which can readily provide special shelves for storing them and special tables to support them while they are being used. There are but few illustrations in the

*The two earlier of the three notable British books were reviewed in these columns on Mar. 17, 1910 ("Town Planning," by H. Inigo Triggs, and "Town Planning in Practice," by Raymond Unwin), on which occasion more general remarks were recorded on city planning and its literature in English. This literature then included, besides the two books just named, two American books by Charles Mulford Robinson, "The Improvement of Towns and Cities," a small book on the more purely physical aspects of town planning (published in 1901), and "Modern Civic Art," which appeared first without illustrations and subsequently with many handsome views (see our issues for June 6, 1903, and Apr. 13, 1905, for notices of the two books). Another American book which deserves mention because of its many city plans, maps, and its valuable discussions of financial problems is Richard M. Hurd's "Principles of Land Values," noted in this journal on Mar. 17, 1904.

work under consideration which could not have been brought within a large octavo page. Even had a smaller page made two volumes necessary the gain would probably have overbalanced the loss, although a single volume is a great convenience when one is so constantly invited, as in this case, to refer to illustrations which are unavoidably placed in another part of the book.

The book is so valuable an addition to the literature of the subject that those interested in the esthetic side of town planning might well add it to those named in the footnote at the beginning of this notice—if the high price necessarily charged for such a book is not prohibitive. The fact that many who could profit by the volume will not feel able to purchase it is an added reason for the acquisition of the book by all public libraries located in cities where an interest in town planning exists.

The Cause and Prevention of Industrial Depressions

INDUSTRIAL DEPRESSIONS—Their Causes Analyzed and Classified with a Practical Remedy for Such as Result from Industrial Derangements. Or, IRON THE BAROMETER OF TRADE. By Geo. H. Hull. New York: Frederick A. Stokes Co. Cloth; 6x9 in.; pp. 287; two folding charts. $2.75, net.

If any class of men have reason to be cast down by industrial depressions it is engineers, for while they may not suffer thereby so directly as do capitalists and manufacturers, they often suffer far more keenly, since the sole capital of many engineers is their professional ability and the opportunity to use it, and the latter is often lost when an industrial depression occurs.

Both Mr. Hull's explanation and remedy for industrial depressions should appeal to engineers with particular force. He rejects the theory current in some circles that overproduction is the cause of industrial depression and asserts that man's capacity for the products of the fields and shops and the industrial arts generally is unlimited, provided only he be given opportunity to continue uninterruptedly in well paid work. He believes that industrial depressions, as contrasted with financial panics, arise from low prices which stimulate various lines of construction for investment purposes, as well as other kinds of production. Contracts at the low prices are taken for future delivery, but before the dates of actual manufacture and delivery the stimulus of heavy production causes prices of all commodities to go up. Slow deliveries because of many unfilled orders and haste to get goods not already contracted for before prices go higher, both contribute to the advance in prices. Abandoned plants of all kinds are opened and new ones are built, and as soon as or soon after production and prices reach their maximum, the very highness of the prices causes investors in new construction to call a halt, because they can see no return on their capital. Demand ceases. Prices fall, but more gradually than they rose. For a time stagnation prevails. Sooner or later the cycle is repeated, but the cycles are irregular in time and length and cannot be definitely predicted. The remedy, which should appeal particularly to engineers, is a comprehensive national or international system of recording construction contracts, including amounts and delivery dates for various classes of material. Associated with this should be a record of actual deliveries, and consolidated inventories of stock in hand. Possibly we have not represented the author with complete accuracy in every detail, but we have given the spirit of his argument.

What we have failed to do, thus far, is to give any conception of the careful statistical and descriptive analysis employed by the author to reach his conclusions. He reviews the history of industrial development and shows how agricultural products have become smaller and smaller and are now a surprisingly small percentage of the total products of the industrial arts. Manufacturing industry has increased by leaps and bounds. This, and particularly products used for more or less permanent construction work, demands great quantities of iron and steel. A keen analysis of the many theories of industrial depression heretofore advanced leads to the rejection of most of these as utterly fallacious and to the characterization of the remainder as attendant conditions, rather than actual causes. A further analysis, this time of the industrial depressions which have occurred in America and Europe since 1800, discloses that these depressions have been common to the heavy iron-producing nations of the two continents and that the depressions have accompanied changes in the volume and prices of iron. Numerous statistics and a number of diagrams are submitted in support of this finding—which gives the book its subtitle, "Iron the Barometer of Trade."

The book is much more interesting than might be supposed from its title. Omitting the appendixes, which are useful for reference but do not demand reading, it is relatively brief. It deserves wide reading and careful attention, because if the theories advanced are correct the remedy proposed should be applied, and the latter cannot be achieved except by an awakening of intelligent and somewhat extensive public interest. If the theory be wrong, it should be disproved and a correct one advanced, to the end that industrial depressions may be stripped of their mysteries and fallacies and that the good common sense and business and scientific ability of this and other countries be brought to bear to decrease the frequency and violence of such depressions—for it seems unlikely that Mr. Hull's or any other plan will eliminate industrial depressions, however much these disasters might be reduced.

Finally, we presume that a broader study than has been attempted by Mr. Hull would show that other causes, not considered by him, play a most important part in the rise and fall of prices. Those who wish to pursue the subject further might consult, to mention only one, but a recent and important book, Prof. Irving Fisher's "The Purchasing Power of Money," reviewed in our issue of Nov. 16, 1911.

The Early History of Panama

OLD PANAMA AND CASTILLA DEL ORO—Dedicated to the Builders of the Panama Canal. By Dr. C. L. G. Anderson, Medical Reserve Corps, United States Army; Late Physician Isthmian Canal Commission, etc. Washington, D. C.: The Sudwarth Co. Cloth; 6½x9¾ in.; pp. 600; 42 text illustrations. $5, net.

It is in a certain sense true that as a result of building the Panama Canal the United States has rediscovered Panama. Interest has been aroused in the geography of the new route to the Pacific, and with it comes inquiry as to the history of the Central American region, concerning which the average resident of the United States has hitherto known so very little.

The many engineers who have at one time or another been connected with the Isthmian Canal enterprises have had their curiosity aroused by the strange old ruins buried here and there in the jungle, evidences of a bygone civilization. The book before us offers the means of satisfying that curiosity.

It is not a pleasant or heroic tale the historian has to tell. Indeed his "foreword" opens with the declaration that while the discovery of America was the greatest event in history, the cruel conquest and almost complete annihilation of its native people was the greatest wrong known to mankind.

It must be confessed that viewed from an impartial standpoint today, the aborigines, who met in almost every instance the first approach of white men with hospitality and friendship, were far more deserving the name Christian than were the inhuman Spanish explorers who repaid hospitality with treachery and treated the natives as if they were wild beasts.

The period covered in this history is that between the first voyage of Columbus in 1492 and the failure of the Scotch attempt to found a colony at Darien in 1700. The opening chapter describes the geography of the Panama isthmus and recounts the historic events in connection with the principal localities upon it. The following five chapters are devoted to the voyages of Columbus, then the history of the early exploration and settlement on

the isthmus is taken up, with more or less reference also to the coincident exploration and conquests in Peru and Nicaragua. Chapter 18 reviews the early search for a strait to furnish a waterway across the isthmus, and some of the early projects for a canal. The later chapters have to do with the Buccaneers and the famous (or infamous) expedition of Morgan.

It would be an interesting question for the student of heredity and the philosopher to trace the sequence between the cruelty, licentiousness, and corruption which continued during the first two centuries of Central American history following the discovery by Columbus and the course of their history since. Certainly a knowledge of this past is requisite to a clear understanding of what these countries are today.

Dr. Alexander's work contains numerous reproductions and quotations from original documents, adding much to its interest and value. It will certainly find many interested readers among the engineering profession.

British Municipal Water Works and Gas Works Directories

THE MUNICIPAL YEAR BOOK OF THE UNITED KINGDOM FOR 1912—Albert E. Cave, Editor. London: The Municipal Journal, Ltd. Cloth; 6x9¼ in.; pp. 1131 + xxxix. 15s., net; American price, $6, net.

THE LOCAL GOVERNMENT ANNUAL AND OFFICIAL DIRECTORY, 1912—Officially corrected. Edited by S. Edgecumbe Rogers. London: The Local Government Journal Office (27a Farringdon St.) Cloth; 4¾x7 in.; pp. 292. 1s. 6d., net; American price, 60c., net.

THE WATER-WORKS DIRECTORY AND STATISTICS, 1911—Including Alphabetical Index of Officials and List of Associations of Water Engineers. London: Hazell, Watson, & Viney, Ltd. (52 Long Acre, W. C.). Cloth; 5½x8½ in.; pp. 414 + lvii. 10s. 6d., net; American price, $4.25, net.

THE GAS WORKS DIRECTORY AND STATISTICS, 1911-12—(Revised to August, 1911.) With a list of Chairmen, Managers, Engineers and Secretaries, and lists of Associations of Engineers and Managers. London: Hazell, Watson, & Viney, Ltd., 52, Long Acre, W. C. Cloth; 5½x8½ in.; pp. lxviii + 491. 10s. 6d., net; American price, $4.25, net.

The British "Municipal Year Book" has grown in size and usefulness alike until now it is a thick volume of 1131 pages, covering nearly every phase of municipal activity on which information could be desired. The plan followed is to give the population (this year the 1911 census figures), rateable value, debt and area of each municipality. There then follows a readable paragraph, ranging from a few lines to a page or more, in which the history and principal activities of the municipality are given. Then come the names and street addresses of the mayor, aldermen and councillors, and the names only of the "chief officers." This plan applies to cities and boroughs. For the urban districts, which come next in rank, less information is given, while for rural districts only the clerks, surveyors, sanitary inspectors and in some cases a highway official are given.

All this, however, occupies only half of the book. The remainder is taken up with numerous sections, each devoted to a single municipal activity: as water and gas supplies, tramways (these three almost wholly statistical), refuse disposal, sewage disposal, education, housing of the working classes and town planning. Taxation returns and other statistics are also included. Each of the many sections has a general introduction. Some of these introductions include lengthy synopses of pertinent legislation, which, in the case of town planning, includes the whole of the notable act of 1909. Privately owned water-works, gas works, tramways, etc., are not included.

"The Local Government Annual and Official Directory" covers less thoroughly a part of the field so fully covered by "The Municipal Year Book," and gives a little information not found in the larger book. It has the advantages of convenient size, availability for quick reference and low price. It is chiefly a directory and as such is satisfactory as far as it goes.

The two volumes on water works and gas works appear to follow closely the lines of earlier editions of these standard reference works. Unlike "The Municipal Year Book," both publicly and privately owned works are given.

For water works, we find, among other information, ownership, names of officials, outstanding loans and interest rates, places supplied (works supplying two to a half dozen or more places are common), date of building works and of purchase by town when privately built, source and mode of supply, character of water (sometimes with analyses), capacities of reservoirs, character of purification, if any, pressure, population supplied, average death rate, per capita consumption for domestic and trade purposes, total yearly consumption, water rates, number of meters, miles of mains and total water rents for the year. The low per capita consumption is all the more striking to an American in view of the few meters used.

For gas works the same general range of information is given as for water works, with such differences in details as would be expected. Totals are given for coal carbonized, gas, coke and other residuals made. Prices for gas and coke, number of consumers, meters, stoves and public lamps, and the practice in supplying free fittings are given.

The value of the gas- and water-works directories would have been increased by the addition of editorial summaries, and more of these might well have been given in "The Municipal Year Book." True, when so much valuable, well arranged information is given it seems almost ungracious to ask for more, but the editors and publishers of these useful directories have shown so strong a desire to make them as useful as possible that we feel they will welcome friendly suggestions for further improvement.

Finally, we may mention that in our issue of Nov. 16, 1911 (p. 42), we reviewed another highly commendable British directory, entitled "The Public Health Service Directory and Year Book."

Malaria and Mosquito Reduction

THE PREVENTION OF MALARIA—By Ronald Ross, D. P. H., L. L. D., etc., Noble Laureate. New York: E. P. Dutton & Co. Cloth; 6x9¼ ins.; pp. 669; 36 text illustrations. $5, net.

The debt of gratitude which the world owes to Ronald Ross for his pioneer investigations into the cause of malarial infection and his practical work in the reduction of mosquitoes after he had proven that the anopheles species of this insect spread the disease has been greatly increased by the publication of this book. The volume is about equally divided between a general treatise on malaria and its prevention, by Major Ross, and a series of reviews of anti-malaria and anti-mosquito work, all over the world, by 21 special contributors.

Major Ross first outlines the history of malaria in ancient and modern times, including research on the mode of infection and the discoveries of himself and other workers in this field. He then summarizes the known facts and various observations and experiments relating to malaria, describes in detail how the malarial parasites invade man, multiply there and decline, with or without treatment. Special consideration is given to quinine treatment, in the efficacy of which the author is, of course, a firm believer, provided the dosing is sufficiently large and continuous.

A full hundred pages are devoted to "Malaria in the Community," in the course of which the author presents a detailed mathematical exposition of the laws which regulate the amount of malaria and the number of anopholene mosquitoes in a locality, discusses the measurement of malaria, and the mortality and cost of the disease. This chapter will appeal strongly to those interested in the application of mathematical formulas and the laws of chance to the incidence of disease.

The final chapter of Major Ross's section of the book is on "Prevention." Here all phases of the subject are reviewed, including protection against mosquito bites, mosquito reduction, quinine treatment,

general sanitation and public measures of protection, including anti-malaria campaigns.

The special contributors are headed by Prof. L. O. Howard, of Washington, D. C., and Col. W. C. Gorgas, of Havana and Panama fame, who review malaria prevention and mosquito reduction work in the United States and Panama, respectively. J. A. dePrince also writes on the work in Panama, dealing with its technical features. Other parts of the world covered by the special contributors include the West Indies, Jamaica, the Amazon region, South Brazil, Spain, Italy and Greece; the German Possessions in Africa and the South Seas; the French Possessions in North Africa, Madagascar and elsewhere; work in Egypt, Khartoum, South Africa, Durban, the Malay States, Japan and, that nothing be overlooked, in "Other Countries." Troops in war and in peace are given separate treatment.

Various notes and a bibliography are appended. Instead of a comprehensive index, which is much needed for such a book, the ordinary "Contents" is supplemented by "Contents in Detail," which does not go far toward making up for the lack of an index.

The book as a whole bears eloquent testimony to the vast amount of self-sacrificing, painstaking work, done all over the globe and often under most trying conditions, which has been carried on during the past twenty years to relieve mankind of one of the most burdensome diseases which it suffers; for while the fatality rate is low, few persons out of the teeming population of many parts of the world escape the disease, so the total death rate is high, and the toll upon industry and wealth, to say nothing of human comfort, is enormous. Yet in the face of this sapping of industry, health and life, and the certainty and low cost of controlling and sometimes of virtually eliminating the disease, many of the devoted anti-malaria workers have had great difficulty in securing adequate public funds to carry on their work; and some have brought mosquitoes and malaria alike under almost complete control, only to have further appropriations denied, and to see the enemy return with unabated force—for the war against mosquitoes and malaria, like that against all disease and evil, is never-ending.

Topographic maps for various sections of the country have been published by the United States Geological Survey (Washington, D. C.) as follows: Gridley, Calif.; Hartwick, N. Y.; Miami Copper Belt, Ariz.; Mount Goddard, Calif.; New Athens, Ill.; Randsburg, Calif.; Rochester, N. Y., and Rochester Special, N. Y. As many of our readers know, these maps may be obtained for 5c. each, or at the rate of 3c. each for a hundred or more.

Sociological and Conservation Studies in China, Japan and Korea

THE CHANGING CHINESE—The Conflict of Oriental and Western Cultures in China. By Edward Alsworth Ross, Ph. D., LL. D.; Professor of Sociology in the University of Wisconsin. Author of "Social Control," "Foundations of Sociology," "Social Psychology," etc. New York: The Century Co. Cloth; 5½x8½ in.; pp. 356; 88 text illustrations. $2.40, net.

FARMERS OF FORTY CENTURIES—Or Permanent Agriculture in China, Korea and Japan. By F. H. King, D. Sc.; formerly Professor of Agricultural Physics in the University of Wisconsin, and Chief of Division of Soil Management, U. S. Department of Agriculture. Author of "The Soil," "Irrigation and Drainage," "Physics of Agriculture," etc. Madison, Wis.: Mrs. F. H. King. Cloth; 5½x7¾ in.; pp. 441; 248 text illustrations. $2.50, net.

By happy coincidence or by design there have been published almost simultaneously two vitally significant and interesting books on China—one of which also deals with Japan and Korea. Prof. Ross' book is a wide-ranging sociological and economic study of China and the Chinese. The late Prof. King's volume is primarily a study in agriculture and conservation, but incidentally it contains much of economic sociology. Each author spent a number of months on the ground, and thus writes from first-hand observation.

Perhaps the features most common to the two books are the emphasis laid upon the enormous pressure of population, the consequent struggle with nature for existence, and the untiring energy of the Chinese—and so far as Prof. King's book goes, of the Japanese as well.

As has been intimated, Prof. Ross's book is a far-reaching study of the Chinese nation and problem, and especially the problem of "The Changing Chinese," which is a world problem. He gives thoughtful consideration to the "Race Fiber" and "Race Mind" of this people, devotes 40 pages to "The Struggle for Existence," and considers China's "Industrial Future." Among other subjects treated quite fully are the "Opium Evil" and "The New Education."

Particularly interesting are the author's remarks on the comparative freedom of the Chinese from blood poisoning, dysentery, typhoid and smallpox, and in general their immunity "from the poisons of congested life." The struggle for existence is primarily due to overpopulation, which is attributed largely to ancestor worship.

How the struggle for existence has been met by a marvelously intelligent agriculture and a wonderful maintenance of soil fertility is told in detail by Prof. King. The two things the Chinese seem to have most notably failed to conserve are their forests and their own labor. The forests seem to have well-nigh disappeared, but Prof. King notes various examples of forest conservation and of reforesting. As for human labor, this is wisely directed within limited fields, but except for certain crude mechanical appliances, everything is done by sheer muscular effort.

Water power is used in a primitive way to raise water for irrigation and a considerable amount of animal power is used for ploughing, for grinding and for transportation, but after all the impression given by Prof. King is that the chief power used in China is that of its men, women and children. These are so numerous, so hard working, so poorly paid, and withal so efficient, as to render the use of much machinery out of the question until conditions materially change.

The irrigation canals of China; the terracing of its hillsides to facilitate irrigation and cultivation and to prevent erosion; the utilization of both human and vegetable organic wastes as fertilizing material, by means of liquid manures, compost heaps, and green manures; the utilization as a fertilizer of silt from canal beds; and the skillful working of the soil to unlock plant foods, are all told and retold with never-flagging enthusiasm by Prof. King. Crop yields and costs, land rents and revenues, are given again and again.

Each book, of course, was written before the late revolution in China. The revolution makes Prof. Ross' book particularly timely. In fact, his title is in itself a prophecy — fulfilled, perhaps, sooner than even he expected. In quite another way Prof. King's book is even more timely, as it also is of more immediate practical value. It offers many lessons to the American farmer, who, as the author repeatedly urges, exhausts the fertility of his land in less than a century, whereas after forty centuries of heavy cropping Chinese farmers are still producing enormous yields.

CHEMICAL AND BACTERIAL REPORTS OF THE METROPOLITAN WATER BOARD (London)—By Dr. A. C. Houston, Director of Water Examination. London: The Board. Paper; 8x13 in.

Fifth Annual Report for year ending Mar. 31, 1911. Pp. 56.

Seventh Report on Research Work. Pp. 79.

Eighth Report on Research Work: The Softening, Purification and Sterilization of Water Supplies. Pp. 20.

Further evidence of the remarkably able research work being carried on by Dr. A. C. Houston in connection with the water supply of London, England, is afforded by these reports. The annual report for 1910-11 which, it is only fair to say, was published some months ago, contains the results of routine examinations during the year as well as summaries of the research work. The especial points of interest in the research work mentioned in the annual report pertain chiefly to the bactericidal value of water storage.

The Seventh Research Report is in six parts, each outlining a special line of investigation, but all the lines of investigation are related to the general subject of the bacterial contents of the London water supply and methods of eliminating them. The subjects of the several parts are as follows:

I. Search for Pathogenic Microbes in Raw River Water.

II. The Comparative Vitality of "Cultivated" and "Uncultivated" Typhoid Bacilli in Artificially Infected Samples of Raw River Water.

III. The Comparative Vitality of the Typhoid Bacillus in Raw Thames Water at Different Temperatures.

IV. On the Biological Characters of B. coli Isolated from (i.) Raw River Water; (ii.) Stored Water; and (iii.) Stored and Filtered Water.

V. On the Advantages of Passing Raw River Water through Small Reservoirs, Antecedent to Storage in Large Reservoirs.

The Eighth Research Report on "The Softening, Purification and Sterilization of Water Supplies" details the methods, results and conclusions of experiments with treatment of water with excess of lime primarily for bacterial reduction or elimination, and secondarily for softening purposes. After dosing the water heavily with lime and allowing from 5 to 24 hr. time for the lime to act, the excess of lime was removed by the addition of 25% of untreated water. The author does not claim to have worked out fully the economics of this method of treatment, but he does state that the lime required would alone cost about twice as much as sand filtration. As he does not propose to dispense with sand filtration, and as a large outlay would be required for works to apply the lime to the water, to say nothing of the proposition to disinfect the 25% of water added for neutralizing the excess of lime, it can be seen that the method experimented with would be a very expensive one.

Why the author should give serious consideration to the use of such immense quantities of ordinary lime for disinfection as a preliminary to filtration, when very small quantities of chloride of lime would serve for the disinfection of the free effluent, the report does not make clear. It should be stated, however, that the experiments were made in conjunction with Dr. Houston's efforts to find some workable method of supplementing what is virtually bacterial disinfection by water storage, the supplementary process being desired for use at times when the river water is particularly bad, but cannot be excluded from the supply on account of lack of insufficient storage or the necessity of keeping the pumps in operation. The supplementary process may also soon be needed to make up deficiencies in the storage, due to the more rapid growth of population and lack of storage facilities, Parliament having recently refused to endorse the full program of the Metropolitan Water Board for providing additional water storage between now and 1941.

The Theory of Factory Accounting

FACTORY ACCOUNTS: THEIR PRINCIPLES AND PRACTICE—A Handbook for Accountants and Manufacturers. By Emile Garcke, Managing Director of the British Electric Traction Co., Ltd.; and J. M. Fells, Incorporated Accountant, formerly General Manager of the Salt Union, Ltd. Sixth edition, revised and considerably extended. New York: McGraw-Hill Book Co. London: Crosby Lockwood & Son. Cloth; 5x8 in.; pp. 292; five diagrams in text; tables. $2.50, net.

In a bank it is obviously necessary that the proper authorities should be able to ascertain from the books at any hour the balance of cash on hand and the amount and character of securities in the vaults. It is also becoming realized, more and more each year, that detailed records of every activity need to be kept in every industrial concern of more than one-man size and in such accessible form that economy in the use of materials may be studied and that labor may be made most effective. All private as well as public business seems to be coming closer to a price basis of cost plus a reasonable profit and it is becoming essential to have prompt and accurate distributions of all expenses to each order and job. Therefore the authors have developed in this book forms which are not mere memoranda, but balancing entries of a symmetrical system. It is really the extension of a double-entry balancing-ledger scheme to labor, materials, capital and depreciation accounts, etc.

This book opens with a presentation of the economic necessity of keeping accounts with the punctility of a bank. The second chapter is on labor accounts and shows methods of checking the hours of employees and the distribution of their time to actual jobs, accurately in accordance with the actual work, and not perfunctorily. Accounts are arranged for what we may call "wasted labor" due to lost motion in the factory—failure to keep the men supplied with tasks, tools, etc. This scheme prevents overloading some jobs with labor which was not expended upon it and shows the management ways in which economy is to be sought. The labor accounting forms shown here are carried into great detail of refinement, there being records of direct-time allocation, outside time, overtime, piecework analysis, wage summaries, etc., all worked out to give immediately accessible information for the head of a concern. Specimen workmen's cards and tickets, and summation-book pages are shown.

The third chapter shows accounting for stores of materials in such a way as to naturally lead to economy in purchase and use, and to furnish the officials with summaries of operations involving raw materials. Initiative in the purchase of materials is taken by someone in touch with the details of manufacture such as the foreman storekeepers, who keep a record of their requirements in a requisition book. The various requisitions, regularly brought together, form the basis of the purchasing office's request for quotations or orders. All goods received pass through the stores accounts even if ordered for particular work and the invoices are entered in a "stores-received" book, which is posted into a stores ledger, these two books bearing the same relation to actual stores as the debit side of the cash book and the cash account in the commercial ledger do to actual cash.

Initiative in the use of materials takes the form of instructions from the sales manager to the works manager to make certain articles for stock and authorizing the withdrawal of raw materials needed. However, before the order is given, some person, like a designer or draftsman acquainted with the processes and details of the work to be done, estimates the probable cost in wages and materials, and the time that different classes of machinery will be used. The shop foremen then can draw upon the storekeeper for material to the estimated amount.

Having developed the routine leading up to the payment of wages and to the receipt and issue of all materials, it is necessary to develop forms to show how these two independent factors may be combined to give the cost of manufacture. The various actual expenditures are allocated to the several orders and entered in a cost ledger, together with the charges for machinery directly used.

The cost ledger as developed up to this point, of course, shows only direct charges against a job. Chapter V of the book shows how shop expenses are to be apportioned and factory superintendence, general use of skilled and unskilled labor, depreciation, etc., are to be distributed over all the various operations Chapter VI is devoted to a discussion of what constitutes fixed capital and what depreciation and dividends may be figured on. This chapter is entirely a discussion from the point of view of the financier, economist and lawyer, and is related to accounting only as outlining general principles and instructions. Chapter VII is on machinery-use charges, which is in part an extension of depreciation, as the latter enters into any rate of machinery hours which takes into account the limitation of useful life. Forms are shown for recording the depreciation allowed on various pieces of machinery and for the allocation of machinery charges to orders.

The book has covered so far accounting for articles up to the completion of manufacture. The authors continue to trace the records which should be made in the distribution of the manufactured commodities. These forms have to do with the (1) transfer of finished articles from factory to warehouse, (2) return

of some articles from warehouse to factory, (3) sale and distribution of manufactured articles, (4) return to the warehouse of rejected articles from the purchaser.

Chapter IX is a discussion of the elimination of the general shut-down for purposes of commonly called inventory, called here "a survey." A survey is recommended for each department from time to time to substantiate the balancing system here worked out, but it is not necessary that the entire works should be shut down in order to carry it forward, and there is not the consequent disorganization of forces.

The following chapter develops some detailed minor accounts which have often been found useful, such as cartage, horses and vehicles, freight rates, railway sidings, packing charges, fuel, provident funds, etc. The final chapter of the book is a discussion of methods of remunerating labor. Here are compared the various views on piecework and on some of the modern premium and bonus schemes, coöperative-production and industrial-partnership plan, etc.

Appendix A is a reprint of Oberlin Smith's paper before the American Society of Mechanical Engineers on "Nomenclature of Machine Details." Appendix B is a summary of the British income-tax acts as affecting the profits of a manufacturer. Appendix C is a review and criticism of decisions on the rating of machinery in factories for tax assessments; D contains some notes on the English law relating to fire insurance; E shows tables for determining the amortization of leases, etc. Following this and before the index is a glossary of terms used.

The present edition must be regarded as bringing up to date one of the oldest and most widely read books on industrial accounting. In the earlier editions the authors outlined a number of principles which have been developed by accountants and manufacturers; the benefits of such extended thought of many minds are gathered in this last edition. While the book specifically develops accountant's forms, it explains throughout the basic economic considerations and the legal decisions which have to be followed in England and which hold largely throughout the world. The book may be called a treatise on the theory and practice of complete industrial accounts and should be added to the library of anyone interested in works management.

The National Fireproofing Co. has issued under the title "The Natco House" a very attractive book of views and drawings presented by various architects in the contest for the design of a $6000 tile residence, inaugurated by *The Brickbuilder*.

Small Sewage Purification Plants

PRACTICAL METHODS OF SEWAGE DISPOSAL—For Residences, Hotels and Institutions. By Henry N. Ogden, M. Am. Soc. C. E., Professor of Sanitary Engineering, Cornell University, and H. Burdett Cleveland, Assoc. M. Am. Soc. C. E., Principal Assistant Engineer, New York State Department of Health. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. vi + 132; 52 text figures. $1.50, net (6/6, net).

There has long been a demand for a book which, leaving out the sanitary problems of isolated buildings without running water and sewage, should also pass over plumbing installations and address itself solely to the question of sewage disposal. This the volume before us does. Moreover, it merits in large degree the adjective practical which forms the first word of its title.

After a brief introduction setting forth the problem of sewage disposal, the authors take up settling tanks; valves, valve chambers and siphon chambers; sub-surface irrigation; sand filters, contact beds and sprinkling filters; broad irrigation; and cost estimates.

Unusual pains have been taken to show by sketches both the elements of design and the methods of construction involved. The illustrations and text dealing with these phases of the main subject are reinforced with a few tables for use in designing sewage-disposal works to serve from 4 to 200 people. These tables give length of tile drains required, dimensions of settling and siphon tanks, required for sub-surface irrigation, and similar data for sand filters and contact beds.

Detailed suggestions are given for estimating costs. It is surprising to find an assumption that with an "ordinary wagon" a load of only 800 lb. of sewer pipe could be hauled, and this with a team costing $4 a day.

The authors favor sub-surface irrigation for single houses and sand filters otherwise, where local conditions permit. Sprinkling or percolating filters are given only general consideration. The authors say:

> Owing to the rather complicated hydraulic features and the somewhat difficult engineering principles involved in the construction and operation of sprinkling or trickling filters, it is not deemed advisable to attempt to describe them in sufficient detail to furnish directions for their construction. The design of a sprinkling-filter system for small as well as for large installations should always be entrusted to an engineer conversant with this line of sanitary engineering. It is believed, however, that the description of such filters given above will aid those who are about to install sewage-disposal plants in the selection of the type of plant best suited to their particular needs and conforming to the conditions peculiar to their situation.

Elsewhere the authors also wisely suggest that a competent engineer be engaged to aid in solving the larger and more complicated sewage-disposal problems likely to come before the readers of the book. From this and also from its general character it is to be inferred that the volume is intended chiefly for laymen—a point that ought to have been made plain in a preface (there is none).

The volume seems well suited to the more intelligent class of householders, small contractors, managers and superintendents of country hotels and institutions, and also to many architects, who, for one reason or another, cannot or think they cannot employ an experienced sewage-works engineer to design, and in case of the larger plants, to superintend, the construction of sewage-disposal works. Engineers in general practice, but without experience in sewage disposal, would also find the book helpful; and even the engineer of long experience in sewage purification may find some of the sketches and tables handy for occasional reference. Finally, it is obvious that a book which tells how to design and estimate the cost of sewage works large enough for a hotel or institution of housing 200 people may sometimes serve equally well for a village or an isolated part of a city of like size.

How to Control Municipal Service Corporations

THE REGULATION OF MUNICIPAL UTILITIES — National Municipal League Series. Edited by Clyde Lyndon King, Ph. D. New York and London: D. Appleton & Co. Cloth; 5x7½ in.; pp. 404. $1.50, net.

For more than twenty years one of the greatest of our many municipal problems has been how best to secure good service at reasonable rates from what have now come to be known as public utilities. In the earlier days this class of service was rendered almost wholly by private companies, water supply being a notable partial but always growing exception. The rapid changes from private to public ownership of various municipal utilities abroad and of water works at home, the lack of ways and means of control of private water, gas and light companies at home, and the inadequacy of such control as were attempted all combined to stimulate a demand for municipal ownership, which swept over the United States like a tidal wave some years ago. But municipal ownership met with strong opposition from vested interests, from conservatives who consciously or unconsciously were of the *laissez faire* school and from many others who based their opposition on no other ground than the fact that most of our American cities had made a sad failure of exercising limited municipal functions and would only add to the prevailing municipal mismanagement and corruption if they assumed further burdens. In addition to all this opposition were the very practicable difficulties often in the way of financing extensive schemes of municipal ownership.

Notwithstanding all the drawbacks and obstacles with which it had to contend,

municipal ownership did make progress and the possibility that it might loom on the horizon at any time brought the officers of many a public-service corporation to a greater realizing sense of their duties to the public and to their stockholders than they had ever had before. At the same time, to omit detail, state and city legislatures and the courts came to the assistance of an awakening public and various means for regulating companies operating under municipal franchises and contracts were provided. The control of steam railways by the Interstate Commerce Commission and of steam and electric railways by a few of the more efficient state commissions suggested that like control over the rates and services of municipal utilities should be tried. A single example of the possibilities of this had long been afforded by the Massachusetts Gas and Electric Light Commission, but for reasons which cannot be gone into here had been but little heeded outside that state.

In 1907 the legislatures of Wisconsin and New York blazed the way for the state regulation of municipal utilities, going far in advance of what had been done in Massachusetts. Since then one state after another has followed suit: some timidly and with half-way or even almost inconsequential measures; others boldly and fully, although in legislative powers granted, in administrative organization, methods and efficiency no state has surpassed these two leaders.

Beside control through state commissions there have been some notable instances of municipal control by municipal commissions. Earlier than either state or local commissions were broad general powers of control granted some or all the municipalities of a state, either by constitution or by statute. California made annual regulation of water rates compulsory by a new constitution enacted years ago. Iowa gave some, at least, of its cities permissive power to establish water and light rates at any time.

Heretofore we have had only fragmentary and scattered accounts of attempts to control municipal-franchise companies. A large number of these accounts have been presented before the annual conventions of the National Municipal League, the most helpful of which have been gathered by Mr. King to form a volume in the series of books now being issued under the auspices of that organization.

Mr. King's book contains more original matter, and important matter too, than would be expected from its title page, where his name appears as editor. He contributes a number of chapters which serve to introduce the book as a whole and its main divisions, and which also give more unity to the whole than is usually found in a volume from many pens. Any unhappy effects due to difference in date of authorship have been largely if not wholly removed by recent revision, either by the original author or by some person conversant with the facts or competent to revise the opinions presented. Some of the matter was written especially for this volume.

The contents are grouped in a general introduction, and in sections on regulation through (1) franchise; (2) municipal and (3) state utility commissions. In addaddition, there is a chapter of general conclusions, by the editor, and finally a helpful selected bibliography and an index.

The section on regulation through franchises contains a chapter on Franchise Essentials, by the editor, and a chapter on Elements of a Constructive Franchise Policy, by Delos F. Wilcox, and Suggestions for a Model Street Railway Franchise, by Mr. Wilcox and James W. S. Peters. Other authors discuss the so-called Massachusetts sliding-scale gas rates, telephone rates (Prof. D. C. Jackson) and a Rapid Transit Policy for Greater New York (Milo R. Maltbie).

The municipal utility commissions considered in detail are those of Los Angeles, Kansas City and St. Louis, and the state commissions taken up at length are those of Massachusetts, Wisconsin and New York. The Massachusetts chapter deals with the gas and electric light, the railway and the highway commissions; the latter controls telephone and telegraph companies. The section of the book dealing with state regulation has an introductory chapter, by the editor, on the relative advantages of state and of municipal commissions. The editor believes both to be desirable and the state commissions to be necessary. He also believes in the indeterminate franchise and in having municipal ownership a possibility in every city.

The value of the book would have been increased had the editor given lists of cities and of states which have public-utility commissions and brief summaries of the powers, organization and work of each commission in the two classes. Such a summary relating to state commissions would clear up a doubtful point as to how many of the state commissions have power to regulate municipality owned utilities. Mr. King writes as though the lack of this power were an exception, while if we mistake not the reverse is true.

A few days after the publication of Mr. King's book there appeared a compilation of the public utility laws of all the states, making some twelve hundred large closely printed pages of the 1911 *Proceedings* of the National Association of Railway Commissioners. What is needed now is a systematic digest of that compilation. The task would be a large one. Space could be found in Mr. King's volume for only a brief summary of the legislation just mentioned, but a summary occupying no more than twenty pages, if judiciously made, would be a welcome addition to the book.

It should be understood that the two immediately preceding paragraphs are suggestive rather than fault finding in character. Mr. King set out to collect, bring up to date, and unify the most important of the various papers on his chosen subject read before the National Municipal League. He merits praise for the admirable way in which he has performed his task.

Fire Assaying Rewritten

Reviewed by BRADLEY STOUGHTON*

A MANUAL OF FIRE ASSAYING.—By Charles Herman Fulton, E. M., D. Sc.; Professor of Metallurgy, Case School of Applied Science. Second edition, entirely rewritten and enlarged. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. 219; 60 illustrations in text; 44 tables. $2, net.

The first edition of this book, which was published in 1907, at once established itself as the standard textbook of fire assaying in America, and was soon adopted by most of the leading universities, mining and scientific schools of the country where the subject was taught. It was reviewed at length in ENGINEERING NEWS of Dec. 12, 1907. Having passed through a third impression since then, the opportunity to add to and revise it in order to record recent progress in Assaying was improved by the author. The subjects of Assay Furnaces, Assay Fluxes, Cupellation, and Special Methods of Assay, have been added to, and the book has been entirely rewritten. The value of the first edition is justly indicated by the prominence it obtained, and the second edition is even better than the first.

An important study of "Sewage Polluted Water Supplies in Relation to Infant Mortality," by Allan J. McLaughlin, past assistant surgeon, U. S. Public Health & Marine Hospital Service, occupied 30 pages of *Public Health Reports* (Washington, D. C.) for Apr. 26, 1912. A number of tables and diagrams are given. Those familiar with the Mills-Reincke phenomenon and with Hazen's theorem will be interested to know that the author concludes that the phenomenon named "when present, is due in greatest measure to the reduction in those diseases which are grouped under the headings of diarrhea and enteritis of children"; also that both the phenomenon and the theorem "are not always apparent after betterment of the public water supply because of wide fluctuations in the death rate for contagious diseases which are not water borne." Doctor McLaughlin's paper is well worth the careful attention of all who have to do with public water supplies or are interested in their improvement.

*Consulting Engineer, 165 Broadway, New York City.

Scientific Management in the Concrete Industry

CONCRETE COSTS—Tables and Recommendations for Estimating the Time and Cost of Labor Operations in Concrete Construction and for Introducing Economical Methods of Management. By Frederick W. Taylor, M. E., Sc. D., and Sanford E. Thompson, S. B., M. Am. Soc. C. E., Consulting Engineer. Authors of "A Treatise on Concrete, Plain and Reinforced." New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. xxii + 709; 82 text figures. $5, net (21/1, net).

The words "Concrete Costs," which form the main title of Messrs. Taylor and Thompson's new book, but inadequately describe its contents. There have been published some books which rightfully could claim no more than this title, books which describe in some detail the cost of various specific concrete structures and from these costs deduce a number of more or less approximate unit costs for the benefit of the estimator of future work. The book before us, however, needs the further description of its sub-title, "Tables and Recommendations for Estimating the Time and Cost of Labor Operations in Concrete Construction and for Introducing Economical Methods of Management." In fact, it should have somewhere in its title the words "Scientific Management" which need quotation marks to fully indicate the source of that science in the active mind of Frederick W. Taylor.

Mr. Taylor states in his preface that since 1894 he and Mr. Thompson have been studying in his now well known manner the intimate details of the building trade. At that early date he became convinced that the same motion and time studies which had developed such effective improvements in the metal-working trades could be profitably applied to the building trades. To quote the preface:

> During the past 17 years Mr. Thompson and his able assistants have devoted practically their whole time to a minute, painstaking study of the building trades, and this is the first book resulting from his work which deals with the time and cost problem. In justice to Mr. Thompson, however, it should be understood that this does not constitute the only fruit of his 17 years of labor. Besides publishing "Concrete, Plain and Reinforced," he has accumulated the data and prepared the tables for books on the following trades, which we hope to publish within a few years: earthwork; brick laying; lathing; plastering; carpentry; slating; and many of the smaller trades.

It will be evident then that while the subject of cost is the main reason for the book's existence the study of how those costs may be estimated for future work and reduced in current practice is the most important matter in its contents.

The book opens with several chapters giving approximate unit and total costs of various types of concrete structures, compiled after the old manner of ascertaining costs and frankly given only as approximations. Following this are several chapters devoted to the science of cost analysis and the application of "scientific management" to concrete work. There then come chapters on methods of proportioning and mixing concrete, having always in view the maximum strength for the minimum cost, the cost of concrete materials, the cost of excavating and crushing stones and of handling and transporting material. The matter of mixing and handling is taken up next and is followed with several chapters on forms and centering. This takes the book through Chapter 16. Chapters 17 to 22 consist of tables for the proper estimating of concrete volumes, steel areas and quantities, cost of bending and placing steel, for designing forms, for estimating quantities of lumber for forms and for estimating times and costs of labor on forms. The last chapter, No. 23, is devoted to the various methods now in vogue for estimating the cost of reinforced-concrete construction and finally explains in detail the methods of estimating recommended by the authors, using the many tables which precede this chapter.

All of this takes 708 pages and a number of tables, but it is printed on fine, thin paper so that the book is very handy for use. It is obvious, however, that so detailed an analysis will not bear complete description in a review. We must confine ourselves then to a general description of the contents of the book and to some comment thereon.

The preliminary chapters on approximate costs have been compiled with great care from technical literature and from personal observation of the authors. The arrangement of the material, particularly the assignment of the structures to their right classes, has been very well done, with the result that the tables of approximate costs are probably more accurate than most costs heretofore given as precise. The authors insist, however, that these chapters can only give preliminary estimates and that the subject of cost of concrete structures is so complicated that a most infinitesimal analysis is necessary to reach any valuable end.

Fundamentally this analysis means the subdivision of the parts of a structure and the methods of building it into the smallest divisions that are alike in all kinds of similar work, regardless of minor differences in construction and the many major differences in design and conditions. The authors, therefore, have set about dividing every portion of a concrete structure into the minute operations which can be analyzed by close observation of similar operations on many different kinds of work. By far the great part of the main section of the book is devoted to these analyses, all representing many years of study but nevertheless reduced to fairly compact form. It will be readily seen that this means much more than mere time analysis because the kinds and conditions of labor and of material and particularly the arrangement of plant must be equally studied with the unit times taken by various laborers to do certain work, and these studies of material and methods are included with the chapters on the time study. The chapter subjects noted above will indicate the extent to which this analysis must go. As an accompanying feature also, there is a considerable space devoted to the familiar principles of scientific management and an exposition of the methods of their application to concrete construction.

To oppose the principles of scientific management in these days of its spectacular publicity is to be misunderstood. In the minds of the public, well fed by the popular magazines and a certain section of the technical press, one is either a hidebound reactionary, antagonistic to the latest and best developments in industry, or an enthusiastic supporter and promoter of the principles laid down by Mr. Taylor and his numerous disciples. Without endeavoring, then, to take a middle ground between these two opinions, we venture here merely to suggest the essential differences between such labor as is ordinarily employed in the machine shop or factory where scientific management has been most successful and the labor which can be obtained on the usual concrete job. The concrete building, dam, bridge or other structure built in the open, under varying conditions of weather, with both skilled and unskilled labor, subject to the peculiarities of engineering supervision and to the uncertainties of natural forces, is a far different type of work than that done in the factory. If so called "scientific management" can be applied in all its details to these complicated conditions, it will surely be a triumph for its originator. Meanwhile, we can but admire the patience and diligence which has resulted in the book which is before us and trust that its students will not be so overcome by the minutiæ of the analyses as to pass over the very essential and valuable material it contains.

STILLMAN WILLIAMS ROBINSON—A Memorial. Columbus, Ohio: The Ohio State University. Boards; 6x 9¼ in.; pp. 75; portrait. Gratis.

The faculty of Ohio State University in its desire to pay tribute to the memory of Prof. Stillman W. Robinson, in more than a passing way, arranged a memorial service at which addresses were made by Prof. Joseph B. Davis of the University of Michigan, Prof. Ira O. Baker of the University of Illinois, and Prof. Embury A. Hitchcock of Ohio State University, at each of which institutions Prof. Robinson had taught. These addresses have here been brought together to form a lasting record of the esteem in which the man was held by his colleagues.

Publications Received

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. The amount of postage necessary can be estimated approximately from the stated size of the book or pamphlet and the number of pages it contains. Reprints of papers read before engineering societies and printed by the authors for private circulation can often be obtained without cost by addressing the author, whose name and address is always given when known. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of a reprint of a society paper to the author of the paper. The stated American prices of foreign books are based on 40 cents per shilling and per mark for British and German books, respectively, and 20 cents per franc for French books, the extra allowances being for importation costs.]

AMERICAN WATER WORKS ASSOCIATION—Proceedings of the Annual Convention, held at Rochester, N. Y., June 9-10, 1911. Troy, N. Y.: John M. Diven, Secretary (47 State St.). Cloth; 6¼x9¼ in.; pp. xiv + 490; many illustrations and tables.

BULLETINS, THE AGRICULTURAL EXPERIMENT STATION OF THE COLORADO AGRICULTURAL COLLEGE—Fort Collins, Colo.: The Experiment Station (L. M. Taylor, Secretary). Paper; 6x9 in.; illustrated.

No. 150: On the Measurement and Division of Water. By L. G. Carpenter. Pp. 48. June, 1911.

No. 151: Alfalfa. The Relation of Type to Hardiness. By Philo K. Blinn. Pp. 16. December, 1911.

BULLETINS, U. S. DEPARTMENT OF AGRICULTURE—Office of Experiment Stations: A. C. True, Director. Prepared under the direction of C. G. Elliott, Chief of Drainage Investigations. Washington, D. C.: Pub. Doc. Paper; 6x9 in.

No. 240: Tidal Marshes and Their Reclamation. By George M. Warren, Drainage Engineer. Pp. 99; 16 plates and 21 text figures.

No. 243: Land Drainage by Means of Pumps. By S. M. Woodward, Drainage Engineer, Drainage Investigations. Pp. 44; 5 plates and 3 text figures.

A CITY PLAN FOR DALLAS—Prepared by George E. Kessler, Landscape Architect of St. Louis and Kansas City. Report of Park Board. Dallas, Tex.: Pub. Doc. Stiff paper; 9¼x12½ in.; pp. 59; many folding plates, diagrams and text illustrations.

COAL AND COMMON SENSE—By Jaques Abrady, M. I. M. E. Reprinted from "Electrical Times," Sept. 7, 1911. Detroit, Mich., and London, England: Precision Instrument Co. Paper; 5½x8½ in.; pp. 16.

CONTRIBUTIONS FROM THE SANITARY RESEARCH LABORATORY AND SEWAGE EXPERIMENT STATION—Vol. VIII. Reprinted papers. Boston, Mass.: Massachusetts Institute of Technology, Department of Biology and Public Health. Paper; 6x9 in.; pp. 48; illustrated. $1, net.

THE EARNING POWER OF CHEMISTRY—Professional Paper No. 5, Contributions to Engineering Chemistry. By members of the staff of Arthur D. Little, Inc., Chemists and Engineers. A public lecture to business men delivered under the Auspices of the American Chemical Society at Indianapolis, June 29, 1911. [Reprinted from "Journal of Industrial and Engineering Chemistry."] Boston, Mass.: Arthur D. Little, Inc. Paper; 6x9 in.; pp. 19; one chart.

THE EFFECT OF TOPOGRAPHY AND ISOSTATIC COMPENSATION UPON THE INTENSITY OF GRAVITY—By John F. Hayford, formerly Inspector of Geodetic Work and Chief of the Computing Division, and William Bowie, Inspector of Geodetic Work and Chief of the Computing Division; Assistant, Coast and Geodetic Survey. Special Publication No. 10, Coast and Geodetic Survey; O. H. Tittmann, Superintendent. Washington, D. C.: Pub. Doc. Cloth; 9x11⅛ in.; pp. 132; 19 illustrations, including 5 maps in pocket of cover.

ENGINEERING VALUATION OF PUBLIC UTILITIES AND FACTORIES—By Horatio A. Foster, M. Am. Inst. E. E., M. Am. Soc. M. E.; Consulting Engineer; Author of "Electrical Engineers' Pocketbook." New York: D. Van Nostrand Co. Cloth; 6x9½ in.; pp. xvi + 345. $3, net.

GAS ANALYSIS AS AN AID IN FIGHTING MINE FIRES—By George A. Burrell and Frank M. Seibert. Technical Paper No. 13, Department of the Interior, Bureau of Mines; Joseph A. Holmes, Director. Washington, D. C.: Pub. Doc. Paper; 6x9¼ in.; pp. 16; one illustration.

THE INFLUENCE OF CARBON UPON NITRIFICATION—By H. W. Clark and George O. Adams. [Reprinted from "Journal of Industrial and Engineering Chemistry," Vol. 4, April, 1912.] Paper; 6¼x9¼ in.; pp. 6. Address the authors, c/o Mass. State Board of Health, Boston, Mass.

THE INITIATIVE, REFERENDUM AND RECALL—Edited by William Bennett Munro. National Municipal League Series. New York and London: D. Appleton & Co. Cloth; 5x7¾ in.; pp. viii + 365. $1.50, net.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS—Proceedings of the 16th Annual Convention, held at Atlantic City, N. J., Sept. 12-15, 1911. [Clarence R. George, Secretary, Houston, Tex.] Cloth; 6x8½ in.; pp. 187; illustrated.

AN INVESTIGATION OF THE COALS OF CANADA—With Reference to Their Economic Qualities, as Conducted at McGill University, Montreal, under the Authority of the Dominion Government. In six volumes. Vol. I. By E. J. Porter, E. M., D. Sc., and R. J. Durley, Ma. E.; assisted by Théophile C. Denis, B. Sc., Edgar Stansfield, M. Sc., and a staff of special assistants. Ottawa: Pub. Doc. Canada Department of Mines, Mines Branch; Eugene Haanel, Ph. D., Director. Stiff paper; 6½x10 in.; pp. xxiii + 243; 5 folding maps, many folding and other plates, and 44 tables. $1, net.

THE MANUAL OF STATISTICS—Stock Exchange Hand-Book, 1912. 34th annual issue. New York: The Manual of Statistics Co. Cloth; 5½x8 in.; pp. xxv + 1098. $5, net.

THE McGRAW ELECTRICAL DIRECTORY—Lighting and Power Edition, Comprising (I.) Central Station List Section; (II.) Dealers' and Contractors' Section; (III.) Buyers' Manual Section. April, 1912. New York: McGraw Publishing Co. Leather; 4¼x8⅜ in.; pp. 741. Subscription price, $10 per year.

THE MECHANICS OF THE AEROPLANE—A Study of the Principles of Flight. By Captain Duchene. Translated from the French by John H. Ledeboer, B. A., Associate Fellow, Aeronautical Society; Editor "Aeronautics," Joint-Author of "The Aeroplane," and T. O'B. Hubbard, Secretary of the Aeronautical Society; Joint-Author of "The Aëroplane." New York, London, Bombay and Calcutta: Longmans, Green & Co. Cloth; 5½x9 in.; pp. x + 231; 91 text figures. $2.25, net.

MINERAL PRODUCTION OF CANADA—Annual Report, 1910. By John McLeish, B. A., Chief of the Division of Mineral Resources and Statistics. Bulletin 143, Canada Department of Mines, Mines Branch; Eugene Haanel, Ph. D., Director. Ottawa: Pub. Doc. Paper; 6½x10 in.; pp. 328.

THE MODERN LOCOMOTIVE—By C. Edgar Allen, A. M. I. M. E.; A. M. I. E. E. Cambridge [England]: The University Press. [New York: G. P. Putnam's Sons.] Cloth; 4¾x6¾ in.; pp. viii + 174; 36 text figures. 1/-, net; American price, 40c., net.

MODERN DESTRUCTOR PRACTICE—By W. Francis Goodrich, Assoc. Inst. M. E., F. Inst. San. E.; Author of "Refuse Disposal and Power Production," "Small Destructors for Institutional and Trade Waste," etc. London: Charles Griffin & Co., Ltd. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 6x9 in.; pp. xvi + 278; 116 text figures; 46 tables. $4.50, net.

THE OREGON SYSTEM OF WATER TITLES—By John H. Lewis, State Engineer. Bulletin No. 2, April 15, 1912. Salem, Ore.: Pub. Doc. Paper; 6x9 in.; pp. 16; illustrated.

THE PARK GOVERNMENTS OF CHICAGO—An Inquiry into Their Organization and Methods of Administration. Report prepared by the Chicago Bureau of Public Efficiency, 315 Plymouth Court, Chicago, Ill. (George C. Sikes, Secy.) Paper; 6x9 in.; pp. 182; tables; folding charts in appendix.

THE PRIMER OF HYDRAULICS—By Frederick A. Smith, Hydraulic Engineer; Asst. Engr., Dept. Public Works, Chicago, Ill. Chicago, Ill.: D. H. Anderson. Cloth; 5½x7¾ in.; pp. vi + 217; 110 text figures; 22 tables. $2.50, net; flexible leather, $3.50, net.

PROGRESS OF STREAM MEASUREMENTS—Report for Year 1910. By P. M. Sauder, C. E. Sessional Paper No. 25d, Department of the Interior, Dominion of Canada. Ottawa: Pub. Doc. Paper; 6½x10 in.; pp. 244; illustrated.

PROGRESS OF THE TIDE IN DEEP INLETS AND ORDINARY ESTUARIES—By W. Bell Dawson, M. A., D. Sc., M. Inst. C. E., F. R. S. C. [From the "Transactions" of the Royal Society of Canada, Third Series—1911, Vol. V, Sec. III.] Ottawa: The Royal Society of Canada. Paper; 6½x9¾ in.; pp. 5.

RAINFALL AND RUNOFF—Discussion of Baldwin Latham's Experiments. By Prof. Dr. Luedecke, Breslau. Reprint from "Der Kulturtechniker." Paper; 6½x9¾ in.; pp. 17; illustrated. [German text.]

REPORT ON REVALUATION OF RAILROADS AND CANALS, NEW JERSEY, 1911. By Charles Hansel, Expert in Charge. Trenton, N. J.: Pub. Doc. Paper; 5¾x9 in.; pp. vii + 465.

SANITARY ENGINEERING SECTION, AMERICAN PUBLIC HEALTH ASSOCIATION—By Rudolph Hering, Chairman, 170 Broadway, New York City. [Reprinted from "American Journal of Public Health, Vol. 2, No. 4.] Paper; 7x10 in.; pp. 54. Address the author.

SOUTHERN INDUSTRIES—The Tradesman Classified Directory and Buyers' Guide for 1912. Issued as The Tradesman 33d Annual. Chattanooga, Tenn.: The Tradesman Publishing Co. Cloth; 6x9¾ in.; pp. 447. $5, including annual subscription to "The Tradesman."

SPECIAL LIBRARIES—Check list of References on City Planning. [Compiled under the editorial direction of H. H. B. Meyer, Chief Bibliographer, Library of Congress.] Indianapolis, Ind.: The Special Libraries Association; subscription office, 93 Broad St., Boston, Mass. [Guy E. Marion, Secretary.] Paper; 7x10 in.; pp. 62. Published monthly, except July and August. Subscription price, $2.

STATE OF NEW YORK—Annual Report of the State Engineer and Surveyor [J. A. Bensel] for the Fiscal Year Ended Sept. 30, 1911. Albany, N. Y.: Pub. Doc. Cloth; 5¾x9 in.; pp. 257; map in pocket of cover and many photographic views.

A TEXT BOOK OF RAND METALLURGICAL PRACTICE—Designed as a "Working-Tool" and Practical Guide for Metallurgists upon the Witwatersrand and Other Similar Fields. By Ralph Stokes, Jas. E. Thomas, G. O. Smart, W. R. Dowling, H. A. White, E. H. Johnson, W. A. Caldecott, A. McA. Johnston and C. O. Schmitt. Vol. I. London: Charles Griffin & Co., Ltd. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 6¼x9 in.; pp. xix + 468; 128 text figures; 124 tables. $6.50, net.

UNITED STATES GOVERNMENT SPECIFICATION FOR PORTLAND CEMENT—Issued May 1, 1912, Department of Commerce and Labor. Circular No. 33, Bureau of Standards; S. W. Stratton, Director. Washington, D. C.: Pub. Doc. Paper; 7x10 in.; pp 28; 10 text figures.

WAR DEPARTMENT, UNITED STATES ARMY—Annual Report (without appendices) of the Chief of Engineers [W. H. Bixby]. 1911. Volume II. Washington, D. C.: Pub. Doc. No. 401. Paper; 5¾x9¼ in.; pp. 1162.

WATER ANALYSIS FOR SANITARY AND TECHNICAL PURPOSES—By Herbert B. Stocks, Fellow of the Institute of Chemistry, Fellow of the Chemical Society, Member of the Society of Chemical Industry. London: Charles Griffin & Co., Ltd. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 5¼x7¾ in.; pp. viii + 136; eight text figures. $1.50, net.